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DERIVATION OF HUMAN LETHAL DOSES

Toxicology Excellance for Risk Assessment (TERA)

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Human lethal dose estimates are required, in conjunction with U.S. Army Military Exposure Guideline concentrations, to provide toxicity benchmarks for evaluation of candidate toxicity sensors for an Environmental Sentinel Biomonitor (ESB) system for drinking water protection. An approach was developed to estimate human lethal doses (lowest lethal dose - LD_{Lo}) for 26 chemicals having varying amounts and qualities of toxicological data. Readily available toxicokinetic information was used to adjust the human lethal doses for uptake via drinking water consumed over the course of a day. Research recommendations are provided to improve LD_{Lo} estimation approaches.

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Derivation of Human Lethal Doses

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January 19, 2006

Human Lethal Doses

Introduction and Background

The U.S. Army Center for Environmental Health Research (USACEHR) has a need for data on human lethal doses, and for a consistent general method that can be used to derive human oral lethal doses. The human lethal dose data will be used, in conjunction with the Army Military Exposure Guidelines (MEGs), as a toxicity benchmark to evaluate candidate toxicity sensors in an Environmental Sentinel Biomonitor (ESB) system. This system is expected to complement chemical monitoring systems and to provide toxicity identification for a broad spectrum of chemicals in water.

The Multicenter Evaluation of *In Vitro* Cytotoxicity (MEIC) program estimated human oral lethal dose for a number of chemicals, as part of a broader effort to develop an *in vitro* cytotoxicity testing approach that can be used to extrapolate to human lethal doses. In this effort, Ekwall et al. (1998) collected data on human lethal doses in acute poisonings from handbooks on emergency medicine, pharmacology, forensic medicine, and industrial chemical toxicology, in addition to a poison information center. The authors presented the mean lethal doses (LDs) and minimal lethal doses (MLDs) based on the available human data, and then reported the arithmetic mean of the LDs or MLDs. It is important to note that mean of reported acute lethal doses from these sources is simply an average of the available data, and does not represent a human LD_{50}.

The purpose of the current work was to (1) further evaluate the approach used by Ekwall and colleagues, (2) apply a modification of their approach to develop human lethal doses for 26 chemicals, (3) suggest an initial approach that can be applied to chemicals with varying amounts and qualities of data, and (4) develop an approach using readily available toxicokinetic information to adjust human lethal doses based on bolus doses to consider uptake via drinking water consumed over the course of a day.

Approach

Estimation of Human Lethal Doses

The Ekwall et al. (1998) paper was used as a starting point for the current effort. We first collected the text in the handbooks and other secondary sources regarding human lethal doses that were cited by Ekwall et al. (1998). Two of the references cited by Ekwall and colleagues (Persson and Sjoberg, 1997; Moeschlin, 1986) were not accessible to us because they were in foreign languages. This information was supplemented by other standard secondary sources (shown in Table 1 for each chemical). These additional secondary sources were toxicological profiles compiled by (1) the Agency for Toxic Substances and Disease Registry (ATSDR), (2) Registry of Toxic Effects of Chemical Substances (RTECs), (3) the National Institute of Occupational Safety and Health (NIOSH) database of acute toxicity data, (4) the Hazardous Substances Data Bank (HSDB). Table 1 also lists other secondary sources (e.g., Sax's dangerous properties of industrial materials by Lewis; Patty's Industrial Hygiene and Toxicology) and primary literature where applicable. Key primary references identified from secondary sources

were retrieved, to the extent possible, and reviewed. This effort frequently involved repeated iterations of retrieval, because often the references cited by the secondary sources were themselves secondary references.

This analysis began with consideration of the original text from the secondary sources with the aim of identifying additional information regarding the basis for the determination of mean or minimal lethal doses. Unfortunately, most of the secondary sources provided very limited information to aid in the evaluation of the reported lethality values. For example, in many cases in these secondary sources only a lethal dose value was provided with no reported basis for the value. However, citations to primary references were provided by some (but not all) of the secondary sources. When primary references were cited or additional secondary references were identified as the source of reported values, an attempt was made to retrieve and review this additional information. In all, over 150 primary and/or additional secondary references were reviewed to update the analysis presented in the September 30, 2005 version of this report. This current report updates the analysis based on the review of primary and additional secondary references, with new findings presented in Table 1.

We also collected LD_{50} values in rats and mice for the 26 chemicals of interest from the secondary sources listed above and from primary literature cited or identified. This was done both with the aim of comparing the human and animal data, and with the aim of using the comparison in the development of a general approach for chemicals that may or may not have human lethal data. Therefore, we considered how to extrapolate from rodent LD_{50} data to determine a human lowest lethal dose (LD_{Lo}). Limited LD_{Lo} data were available from the animal studies. However, for an initial review of a subset of 14 chemicals, exposure routes other than oral were often used for these studies, rabbits were mostly used and, for the most part, the LD_{Lo}s reported were higher than the LD_{50} for the rat and/or mouse. Based on this experience, LD_{Lo} data were not compiled for the full review that included a combined total of 26 chemicals. As described further in the Results and Discussion Section, the human and animal lethality data were evaluated together to identify a final recommended value for a lowest lethal dose (LD_{Lo}) in humans.

Adjusting Derived Human Lethal Values for 15 L/day Water Intake

Human oral lethal doses are often reported as the amount of a chemical that is lethal when ingested in a single bolus dose, derived from single-dose studies in animals. However, consumption of contaminated water would occur over the course of a day with multiple drinks or bolus doses. Using this assumption, with minimal toxicokinetic information, we derived adjustment factors to take into account that a higher total daily dose may be tolerated for periodic smaller exposures. Qualitatively, this means that for a chemical with a very long elimination half-life a multiplier as low as 1 may be appropriate (since the sequential intakes build the body burden to the same level as the single dose over the course of the day). However, a chemical with rapid elimination could theoretically have an adjustment factor as high as 12 (assuming equal water intakes each hour for 12 hours). To derive such a factor, a simple kinetic model was constructed to compare the total dose consumed through multiple doses to a single lethal dose. It was assumed that lethality corresponds to the peak concentration of the compound in the plasma (as is the case for many mechanisms of acute toxicity such as impaired cell respiration,

acetylcholinesterase inhibition, and narcosis). The dosing (i.e., water intake) was assumed to occur over a 12-hour period with separate intakes 1-hour apart. A further simplifying assumption was that the dose is absorbed instantaneously from the gut, because absorption rate constants are not available for many of the compounds. While these were judged as reasonable default assumptions, as we discuss later in the report, it would be important to conduct additional detailed analysis of case studies to better determine the quantitative impact of these assumptions. The resulting kinetic model is a 1-compartment body model described by the fraction of the dose absorbed (F), the volume of distribution (V), and the elimination rate constant or half life ($k_e = \log(2)/t_{1/2}$).

Given a single bolus dose, the maximum concentration is found at the time the dose is delivered (due to the instantaneous absorption assumption) and is given by:

$$C(0) = F*Dose_{Single}/V \quad \text{(equation 1)}$$

For the multiple-dose scenario, the maximum concentration after the n^{th} dose depends on the dose and the amount of compound remaining from previous doses (O'Flaherty, 1981):

$$C_n(0) = [F*Dose_{Multiple}/V]*[1-\exp(-n*k_e*T)]/[1-\exp(-k_e*T)] \quad \text{(equation 2)}$$

The goal is to find the total $Dose_{Multiple}$ that yields the same plasma concentration after 12 hourly doses as the single dose. The two expressions are set equal to each other, and solved for the ratio of the multiple dose to the single dose. This ratio is a function of only three parameters: the elimination rate constant, the number of doses, and the dosing interval. In the limiting case of k_e being very small, equation 2 reduces to $C_n(0) = n(F*Dose_{Multiple}/V)$. In other words, the blood concentration immediately after the n^{th} dose is the product of the number of doses and the concentration after a single dose. At the other extreme, if k_e is large, $C(0) = F*Dose_{Single}/V$. Rapid elimination means that the maximal blood concentration would be the same as that after a single dose. The multiple dose expression is evaluated with n = 12 and T = 1 hour to simulate 12 hourly doses to determine $Dose_{Multiple}$, the dose in a single ingestion episode. To obtain the total dose ingested over the course of the day, $Dose_{Multiple}$ is then multiplied by 12 to account for the 12 hourly doses. This total dose can then be divided by 15 to determine the concentration in water.

A very limited literature search was conducted for the required kinetic parameter, the elimination rate constant or half-life. The data were searched for in ATSDR Toxicological Profiles, and then in the National Library of Medicine's online database HSDB. In most cases, the half-life is reported rather than the elimination rate constant. The rate constant can easily be computed from the half-life by dividing the natural logarithm of 2 by the half-life:

$$k_e = \log(2)/t_{1/2}.$$

The resulting values are listed in Table 5 for each chemical.

Results and Discussion

Human Oral Lethal Dose Data

The lethality data reported in the reviewed secondary sources and/or primary references and the basis for these values are shown in Table 1. This table shows all relevant data identified in the secondary sources and primary references, whether values were reported as lowest oral lethal doses, minimal lethal doses, oral lethal (fatal) doses, or post-mortem blood concentrations. These blood concentrations were collected with the ultimate goal of using them, in combination with *in vitro* cytotoxicity data and data on time since death, to determine lethal doses. However, insufficient cytotoxicity data are currently available to apply this approach (but see section on "possible future approaches").

While experimental studies with humans to identify lethal doses are clearly unethical, the ideal data source for determination of human lethal doses would be dose-response data in people. Estimates of doses from case reports of fatal poisonings provide information on what doses can be lethal. However, in the absence of additional information, these data do not provide any information on where the dose falls on the dose-response curve, and whether few or most people exposed to that dose would survive. The original case reports may provide additional information on this point, if, for example, there are reports of co-exposed people who survived. An additional limitation of both the secondary sources and the primary case reports is that the actual doses are often not known precisely. Reasonable estimates, however, may be obtained by post-hoc measurements, dose-reconstruction, or estimates of the amount consumed (e.g., when a bottle of pills is ingested).

Because the Army's need is to ensure that sensors are sufficiently sensitive, the need is for a human LD_{Lo}, rather than an LD_{50}. Therefore, we judged that use of the lowest published lethal dose for humans is a more appropriate estimate than the mean reported lethal doses. In addition, any estimate of the average of reported lethal dose is subject to reporting bias, since multiple secondary sources may report a value from the same source. To minimize this bias, if a value of 1 mg/kg was identified in more than one source, we only counted this as a single source for the purposes of calculating the average. Table 2 shows the lowest reported human lethality value (i.e., LD_{Lo}, MLD, or fatal dose) from each of the 13 or more individual sources, the average human lethal dose from these sources, and the selected best estimate for the oral lethal dose for humans. To facilitate comparison across values, all doses have been expressed as mg/kg, based on a 70-kg individual; this is in contrast to the reporting by Ekwall et al. (1998), which was in terms of g. In addition, doses have been converted, as needed, to the dose of the chemical form of interest (e.g., a lethal dose reported for sodium cyanide would be converted to a cyanide ion dose based on the relative molecular weights of these two compounds). Because Ekwall et al. (1998) did not provide information on whether such conversions were conducted, Table 2 does not show the relevant data provided in that reference for the foreign language secondary sources. Table 2 also presents average values across the reported secondary sources. As the first estimate of the human LD_{Lo}, the far-right column presents the lowest of all of the reliable human lethality data for each of the 26 chemicals of interest. Although this estimate is limited by the available fatality data, it is a reasonable estimate.

Animal Acute Lethality Data

In the second part of this analysis, we have evaluated animal LD_{50} data as an alternative basis for developing human LD_{Lo}s. Table 3 shows the LD_{50} values for the rat and mouse, as well as the lowest oral lethal dose for humans determined as shown in Table 2. Experimental animal LD_{50} values shown in Table 3 represent the lowest doses currently available in the literature.

One disadvantage to using animal LD_{50} data is that there can be considerable differences among species, as well as differences among strains within a species. A similar disadvantage exists in the context of risk assessment for chronic exposures. The general approach to address this disadvantage for chronic noncancer risk assessment, in part, is to use the animal model that best represents humans. If it is not known which animal most closely represents humans, then the most sensitive species is used following the general rule used by the majority of health agencies in the world (e.g., Barnes and Dourson, 1988; U.S. EPA, 2002).

A similar approach was used here in extrapolating from animal LD_{50} data. Since no information was available for any of the chemicals of interest regarding which of the species is most representative of humans, the most sensitive species was used as the basis for extrapolation. This approach has the advantage of being health-protective, although it may not be very accurate. A first approximation in assessing accuracy of any risk extrapolated from experimental animal to humans is that if experimental results indicate similar toxicities among different animal species, it is likely that the toxicity will be more similar for humans than not. Therefore, comparison of the mouse and rat LD_{50} values may provide some insight as to the accuracy of the estimate for humans.

Two extrapolations are needed in determining a human LD_{Lo} from rodent LD_{50} data. The first extrapolation is interspecies – from rodents to humans. We used a factor of 10 for this extrapolation, consistent with the general approach in noncancer risk assessment (e.g., International Programme on Chemical Safety (IPCS), 1994). This extrapolation factor provides an estimate of the human LD_{50}.

The second required extrapolation is from the estimate of the human LD_{50} data to the human LD_{Lo}. Determining the factor required for this extrapolation depends in part on the percentage of the population that one wishes to protect with the final value. A larger extrapolation factor would result in a lower LD_{Lo} that protects more of the population. However, excessively large factors would likely underestimate the LD_{Lo}, because at some point a threshold is reached for mortality. Such underestimation is associated with more stringent requirements for sensors.

The value of this second extrapolation factor can be approximated from an analysis conducted with rats on the LD_{50} to LD_{Lo} ratio. Weil (1972) evaluated the slopes of acute lethality curves in rats for 490 chemicals. Dourson and Stara (1983) determined that, for 92% of the chemicals evaluated by Weil (1972), a factor of 10 from the LD_{50} is sufficient to decrease the response to an $LD_{0.13}$ or lower. An extrapolation factor of 3 (half way between 1 and 10 on a log scale) would reduce the LD_{50} to LD_{6}. In deciding whether this factor of 3 should be used for this second extrapolation, i.e., from human LD_{50} to human LD_{Lo}, several issues were considered:

(1) The purpose of this analysis is to estimate the lowest lethal dose in humans and not a subthreshold dose for lethality.
(2) The farther the extrapolation is from the median value (i.e., the LD_{50}), the greater is the uncertainty in the resulting LD_{Lo}.
(3) This proposed approach includes a number of conservative aspects, including choosing the lowest LD_{50}value from a number of different experimental animal data sets.
(4) The primary exposed group of interest would be young, healthy soldiers.

These factors would tend to support a smaller factor, such as 3-fold, for this second extrapolation, although if an intended application of the sensors will include evaluating drinking water for civilian populations, such as in "nation building" applications, the last issue (i.e., #4) would not apply. In addition, other factors could support using an extrapolation factor larger than 3-fold. For example,

(1) Experimental animals are often less variable in response than humans, and so a larger factor is needed to address human variability.
(2) Only 92% of the chemicals were covered by a factor of 10 in the analysis by Dourson and Stara (1983).
(3) Even using the factor of 10 in rodents, lethality could be as high as 0.13%.

Based on a consideration of all issues, this analysis uses a factor of 3 to extrapolate to an LD_{Lo} from an estimate of the human LD_{50}. Overall, this would result in a composite factor of 30 to extrapolate from the experimental animal LD_{50} (10 to account for experimental animal to human extrapolation and 3 for extrapolation from human LD_{50} to a human LD_{Lo}). A primary consideration in this choice of overall factor was the comparison of the LD_{Lo} values based on the available human data and estimated from the experimental animal data. LD_{Lo} values were available from both data sources for 16 of the 26 chemicals of interest (see Tables 3 and 4). No human LD_{Lo} values were identified for ten of the chemicals (acrylonitrile, aldicarb, dimethrin, fenamiphos, geosmin, methamidophos, methyl parathion, 2-methylisoborneol, microsystin-LR, and oxamyl). Using the 16 chemicals for which human LD_{Lo} values were available, the LD_{Lo} estimated from the experimental animal data using a factor of 30 was lower than the LD_{Lo} reported in humans in 14 of the 16 cases, was the same in one case, but was higher in another case (Tables 3 and 4). The proposed approach could easily be modified to use a composite factor of 100 to extrapolate from the rodent LD_{50} if a greater degree of protection is desired, although a factor of 30 appeared sufficient for this set of chemicals.

Adjusting Derived Human Lethal Values for 15 L/day Water Intake

The human lethal dose estimates presented in Table 2 were often derived from single bolus doses. We calculated equivalent total doses for a drinking water scenario. The scenario assumed a water intake of 1.25 L/hour as a single event every hour for 12 hours. The total dose ingested over this 12-hour period that would result in the same LD_{Lo} estimates for a single high volume bolus dose was computed and is shown in Table 6. Note that this value is not the allowable hourly dose and also could differ for other temporal patterns of water intake. As described in the methods (and shown in Table 5), the half-life data were critical to the calculation, since clearance of the chemical from the body over time impacts its accumulation in the body to a lethal dose. Collection of the half-life data was complicated by two factors: 1) only whole body half-life,

which differs from the plasma half-life, was available for some compounds; and 2) the elimination of most compounds is multiphasic and is characterized by more than one elimination half-life. When a range of half-lives was given, the average was used. When an initial and terminal phase half-life was given, the initial phase half-life was used if it was greater than the 1-hour dosing interval. In some cases, only the mean half-life was available.

The time to peak concentration in the plasma is also reported in Table 5 if it was available. These data were also collected because they can be used with the half-life to determine the absorption rate constant, which is the necessary parameter to overcome the immediate absorption assumption. However, as shown in Table 5, the time to peak was not found for many of the compounds.

Some of the half-lives reported were extremely long (e.g., 212 hours for fenamiphos), leading to an adjustment of 1 to the single lethal dose. However, note that with a half-life greater than about 3 hours (see the bold values in Table 5), a substantial amount of the compound could still be present in the plasma when the 12-hour dosing period begins again the following day. This means that the adjustment factor to the single lethal dose could be less than 1 for compounds with long half-lives. Therefore, this analysis is not sufficient for these chemicals, and a more detailed investigation should be conducted. First, a larger literature search should be performed to confirm the half-life values are correct. Second, an analysis of the multiple-day plasma concentration profile should be conducted.

The validity of the assumption of instantaneous absorption can be examined qualitatively by comparing the elimination and absorption rate constants shown in Table 5. For most compounds, the absorption rate is greater than the elimination rate constant and the assumption of immediate absorption is likely to be a good approximation. For the remaining compounds, this could be a poor assumption, and enhancement of the model to include first order absorption from the gut would improve the estimates. However, the time to peak was not found for many of the compounds, and the instantaneous absorption assumption must be retained until a more rigorous literature search can be performed to fill this data gap.

Recommendations

The purpose of the current work was to evaluate the approach used by Ekwall and colleagues, apply a modification of their approach to develop human lethal doses for 26 chemicals, and suggest an initial approach that can be applied to chemicals with varying amounts and qualities of data. We also provide a method for calculating equivalent lethal doses for intake of the chemical in drinking water over a defined period. We found the approach used by Ekwall and colleagues to be a good start to the overall objective of developing lethality data for humans. However, because the Army's need is to ensure that sensors are sufficiently sensitive, we judged that the need is for a human LD_{Lo}, rather than an LD_{50}. Thus, the use of the lowest published and reliable lethal dose for humans is a more appropriate estimate than the mean reported lethal doses.

As shown in Table 4, this approach results in values considerably lower than those identified by Ekwall et al. (1998). Of the 26 chemicals evaluated in the current analysis, Ekwall et al. (1998)

developed mean human minimal lethal doses for 10. The values recommended in the current analysis were lower than those identified by Ekwall et al. (1998), by a factor ranging from 3 to about 270. This is both because we are recommending the use of the lowest reliable human lethal dose, rather than the mean, and because we recommend using the lower of the reported human LD_{Lo} and the human LD_{Lo} extrapolated from experimental animals. In addition, many instances exist where such human data are not available. In these cases, dependence on available and reliable experimental animal data is reasonable. However, the use of these experimental animal data necessitates some adjustment in order to estimate the likely human condition. Such adjustment has often been accomplished through the use of extrapolation factors. We recommend the use of a 30-fold extrapolation factor with the lowest available experimental animal LD_{50}.

Finally, when faced with information in the form of an observed human LD_{Lo} and estimated LD_{Lo} from experimental animal data, we recommend the choice of the lower value. This is consistent with a protective stance in the face of generally large uncertainty. Based on these recommendations, we propose a human oral lethal dose for each of the 26 chemicals. Table 4 shows these proposals.

The following approach is recommended as an initial general approach for determining a human LD_{Lo} for any particular chemical:

1. Collect reported human lethality data from handbooks following the approach of Ekwall and colleagues, supplemented by the additional references used in this analysis.
2. If possible, trace data from handbooks back to original sources, due to errors in secondary sources, even peer-reviewed ones.
3. Exclude data that are considered highly unreliable.
4. Convert data to common dosing units.
5. Pick the lowest reliable human LD_{Lo}.
6. Collect rodent LD_{50} data.
7. Exclude any unreliable data.
8. Estimate a human LD_{Lo} by dividing the lowest rodent LD_{50} by 30. This factor reflects 10-fold for experimental animal-to-human extrapolation and 3-fold for extrapolation from the human LD_{50} to a human approximately LD_6.
9. Pick the lower of the reported human LD_{Lo} or estimated human LD_{Lo}.

Potential Future Areas of Research

This analysis has developed a generic approach for developing estimates of human LD_{Lo} values, regardless of the quality and depth of the database. More sophisticated approaches are possible with higher quality data sets for individual chemicals, and methods are under development that will aid in the better estimation of these values for a broad range of chemicals. These other approaches were not pursued because of the limited nature of the current project, but could be considered in future work:

(1) The current project used secondary sources, followed by retrieval of relevant key primary references and additional secondary references, to identify lethality data, and develop a

human LD_{Lo} from these data. However, it is possible that other government agencies or other researchers have conducted similar work to develop a consistent LD_{Lo}. It may be fruitful to contact government agencies and other researchers and to conduct additional literature searches.

(2) The current project focused on oral data. Similar efforts can be done for inhalation data. For chemicals where inhalation lethality is due to a systemic effect, it may be fruitful to consider route-to-route extrapolation from inhalation to the oral route. Such extrapolation would not be appropriate when inhalation lethality is due to effects in the respiratory tract. Use of inhalation data may substantially enhance the database, due to the relatively large number of occupational accidents and associated lethality. In addition, the NIOSH Immediately Dangerous to Life and Health (IDLH) values are often extrapolated from lethality data, and so could help inform the development of LD_{Lo} values.

(3) The MEIC program is currently evaluating a number of cytotoxicity tests and evaluating the results as predictors of lethality. We evaluated the data presented on the MEIC web site http://www.cctoxconsulting.a.se/meic.htm (accessed August 2004) and several of the publications from that program. The program has made considerable progress in identifying a suite of key cytotoxicity tests, but as of the date reviewed had not yet developed a consistent approach for being able to extrapolate from the cytotoxicity data to human lethality data.

(4) For some chemicals, postmortem levels of the chemical in the blood or serum were available. We considered using these data to estimate human lethal doses. Such data often have the advantage of being measured (as opposed to estimated ingested doses), and such data may be more plentiful than dose data. However, in order to use such data, one would need an approach for extrapolating from serum data to external dose. This might be done using estimates of volume of distribution, if the time since dosing were known. However, this additional work was beyond the scope of the current investigation.

(5) The extrapolation approach used in this document was based on the slope of rat lethality data and default assumptions about interspecies differences. This approach could be refined by further evaluating the ratio between human and rodent lethality, and by further exploring the slopes of the rodent lethality curves, using data for a large enough number of chemicals for a reasonable statistical sample. In work sponsored by NIOSH, *TERA* will be conducting an analysis similar to this for inhalation data, in the context of developing IDLH values. That analysis may also provide useful information for the oral route.

(6) A simplistic toxicokinetic approach was developed to evaluate potential adjustments to the human lethal dose estimate derived from a bolus dose to a value assuming equally-spaced intakes over the course of a day. An approach relying on blood or plasma elimination rates was used, but could be refined for those chemicals that have more robust data, such as for absorption kinetics. Furthermore, modifications of these factors for various drinking water consumption patterns should be done, because the estimates derived here, while giving information about the range of potential adjustments, would not adequately protect against larger doses that are more widely spaced (even though the total dose may be the same). For example, for chemicals with rapid elimination, an adjustment factor of 10 may be appropriate for hourly 1L equal doses, but this factor would not be adequate for consumption of 4L volumes at 4-hour intervals. A sensitivity analysis using multiple potential consumption patterns should be done to define rules for applying temporal intake adjustments.

Table 1. Human Oral Lethal Doses

Source	Oral Lethal Dose/Concentration*	Basis
Acrylonitrile [107-13-1]		
Handbook of poisoning	N/A 35 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans LD_{50} in experimental animal(s); species not specified
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
RTECS	N/A 78 mg/kg 27 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (Journal of Hygiene Epidemiology, Microbiology, and Immunology, 1959, Vol. 3, p. 106) Mouse – LD_{50} (Journal of Hygiene Epidemiology, Microbiology, and Immunology, 1959, Vol. 3, p. 106)
ATSDR	N/A 93 mg/kg 27 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (Back et al., 1972). The same value was also reported by Ahmed and Patel (1981), but was obtained from RTECS 1977. Although not cited by ATSDR, Smyth et al. (1969) also reported a higher value of 0.14 ml/kg (112 mg/kg). Mouse – LD_{50} (Ahmed and Patel, 1981). Value was obtained from RTECS 1977.
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics–Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	N/A 78 mg/kg N/A	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983., p. 164) no LD_{50} for mouse
Aldicarb [116-06-3]		
Handbook of poisoning	N/A 0.9 mg/kg	No LD_{50}, MLD, or lethal dose for humans LD_{50} – experimental animal species not given
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{50}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{50}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse; only listed as one of the "highly toxic carbamate derivatives"
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{50}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse; only listed as one of the "highly toxic carbamates"
RTECS	N/A 0.46 mg/kg 0.3-0.5 mg/kg	No LD_{50}, MLD, or lethal dose for humans reported Rat – LD_{50} (Handbook of Pesticide Toxicology, 2001, Vol. 2, p. 1094) Mouse – LD_{50} (Fahmy et al., 1970). This is a primary source for the value as presented for groups of 3- to 6-month-old mice (published in the J. Agr. Food Chem., 1970).
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	N/A 0. 65-0.8 mg/kg 0.3 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 653). (Toxicol Appl Pharmacol 14, 515, 1969 as cited in Sax). This reference is Gaines (1969), and the author reported LD_{50} values of 0.8 mg/kg for male rats and 0.65 mg/kg for female rats. However, this is a review, and no primary source was provided for the values. Mouse – LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 653) (J Agric Food Chem 18, 793, 1970 as cited in Sax). This reference is the same as Fahmy et al. (1970), as reported above.
Ammonia [7664-41-7]		
Handbook of poisoning	30 ml of a 25% concentration of ammonium hydroxide, NH_4OH (49.4 mg NH_4^+/kg , 96 mg/kg as NH_4OH) N/A	Fatal oral dose in humans No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Handbook of Emergency Toxicology	10 ml (0.14 ml/kg; as NH_4OH) (16.5 mg NH_4^+/kg, 32 mg/kg as NH_4OH) N/A	Approximate MLD in humans; concentration of NH_4OH solution used not reported; we assumed this was also a 25% NH_4OH solution. This is a secondary reference with no source provided. No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
RTECS	22 mg NH_4^+/kg (43 mg/kg for NH_4OH) 180 mg $NH4^+$/kg (350 mg/kg for NH_4OH N/A	Human – LD_{Lo} (Deichmann and Gerarde, 1969, Toxicology of Drugs and Chemicals,, p. 95). This is not the primary source for the value, and no source was provided. Rat – LD_{50} (Journal of Industrial Hygiene and Toxicology, 1941, Vol. 23, p. 259) No LD_{50} for mouse
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	N/A 180 mg NH_4^+/kg (350 mg/kg as NH_4OH) N/A	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (Environment Canada; Tech Info for Problem Spills: Ammonia (Draft) p.103, 1981). No LD_{50} for mouse
Sax;s (Lewis R.J)	38.6-51.4 mg NH_4^+/kg (for a 70-kg person) (3-4 ml NH_4OH)	Ingestion of 3-4 ml of NH_4OH may be fatal (Deichmann and Gerarde, 1969, Toxicology of Drugs and Chemicals,, p. 95); no reference specified in this secondary source.

Source	Oral Lethal Dose/Concentration*	Basis
Copper Sulfate [7758-98-7]		
Handbook of poisoning	57 mg Cu^{2+}/kg (10,000 mg or 143 mg/kg as $CuSO_4$); for a 70-kg person. N/A	Fatal dose in humans No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	57-114 mg Cu^{2+}/kg (10,000 -20,000 mg/kg of a Cu soluble salt); for a 70-kg person. 2.5-63 mg/L (average, 31 mg/L) N/A	Range of fatal doses Blood concentration in 7 fatal cases No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	57 mg Cu^{2+}/kg 10,000 mg or143 mg/kg, as $CuSO_4$); for a 70-kg person. 15 mg/L N/A	MLD in humans Lethal blood concentration; form of copper not reported No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
RTECS	20 mg Cu^{2+}/kg (50 mg/kg $CuSO_4$) 119 mg Cu^{2+}/kg (300 mg/kg CuSO4) 34.6 mg Cu^{2+}/kg (87 mg/kg ($CuSO_4$)	Human – LD_{Lo} (Stein et al. ,1976) - Journal of the American Medical Association, 1976, Vol. 235, p. 801) (as cited in Sax's) Rat – LD_{50} (Antifungal Compounds, Sigel, M.R., and H.D. Sisler eds., 1977, Vol. 1, p. 507) (as cited in Sax's) Mouse - LD_{50} (Handbook of Pesticide Toxicology, Robert Krieger ed, 2001, Vol. 2, p. 1361)

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	2.4-254 mg Cu^{2+}/kg (6-637 mg/kg as copper sulfate N/A	13 of 53 patients died after ingesting amount indicated; the individuals provided information on intakes, and the authors indicated that reported doses may be inaccurate (Chuttani et al., 1965). Article was reviewed; amount of copper sulfate ingested in the fatal cases were not known. Therefore, this range is not reliable. No LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
NIOSH	857 mg of $CuSO_4$/kg (reported as 341 mg Cu^{2+}/kg for a 70-kg worker) 119 mg Cu^{2+}/kg (300 mg of $CuSO_4$/kg) N/A	Lethal oral dose in humans (Csiky, 1958). This reference is in a foreign language and, therefore, was not reviewed. Rat – LD_{50} (Siegle and Sisler, 1977). This reference is not available for review. No LD_{50} for mouse
ATLA – Alternatives to Laboratory Animals	N/A 119 mg Cu^{2+}/kg (300 mg/kg $CuSO_4$/kg) 147 mg Cu^{2+}/kg (369 mg/kg $CuSO_4$/kg)	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} Mouse – LD_{50}
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
HSDB	57-114 mg Cu^{2+}/kg (10000 – 20000 mg $CuSO_4$/kg); for a 70-kg person)	Lethal dose in humans (Ellenhorn's Medical Toxicology: Diagnosis and Treatment of Human Poisoning. 2nd ed. Baltimore, MD: Williams and Wilkins, 1997., p. 1556).
	119 mg Cu^{2+}/kg (300 mg/kg $CuSO_4$/kg)	Rat – LD_{50} [WHO; Environ Health Criteria 200: Copper p.101 (1998)]. The WHO source for this value was Lehman (1951; Freshw Biol, 21: 163-179). The Agency also reported a value of 960 mg/kg for $CuSO_4.5H_2O$ (citing Smyth et al. 1969; Am. Ind. Hyg. Assoc. J. 30). Lehman (1951) is not available for review.
	N/A	No LD_{50} for mouse
Sax's (Lewis, R.J.)	433 mg Cu^{2+}/kg (1088 mg/kg $CuSO_4$)	LD_{Lo} for humans (Indian Practioner, 18, 807, 1965). This reference is not available for review.
	119 mg Cu^{2+}/kg (300 mg/kg $CuSO_4$)	Rat – LD_{50} (Agricultural Chemicals, 2, 182, 1977). This reference is not available for review.
	N/A	No LD_{50} for mouse
Krieger (2001)	56 mg Cu^{2+}/kg (140 mg/kg as $CuSO_4$)	Estimated lethal dose (10 g) for humans adults.
	382 mg Cu^{2+}/kg (960 mg/kg as $CuSO_4$)	Rat – LD_{50} (cited Stokinger, 1981). This reference is not available for review.
	NA	Mouse – LD_{50}. Krieger (2001) reported a value of 87 mg/kg as Cu $CuSO_4$ for the mouse, citing Jones et al. (1980). However, Jones et al. (1980) reported LD_{50} of 8.71 mg/kg in the mouse following i.p., and not oral, administration.
Stern et al. (1976)	46.3 mg Cu^{2+}/kg (for a 70-kg person) (116 mg $CuSO_4$)	Lethal dose of cupric sulfate. The authors reported the lethal dose to be as low as 1 g, citing Gleason et al. (1969) as the source, but this reference is not available for review.

Source	Oral Lethal Dose/Concentration*	Basis
Dimethrin [70-38-2]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	N/A 15 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans LD_{50} – experimental animal not specified. Note that the value was reported in the table as 15+ mg/kg. Based on other available data, this value may be in g/kg and reported incorrectly in the reference table.
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
RTECS	N/A 40000 mg/kg 10000 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (Pesticide Index, Frear, C.H. ed., 1976). This reference is not available for review. Mouse – LD_{50} (V/O Mezhdunarodnaya Kniga, 1968)
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	>15,000 mg/kg	Rat – LD_{50}

Source	Oral Lethal Dose/Concentration*	Basis
Ethylene glycol [107-21-1]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	100 g or >100 mL (1430 mg/kg; for a 70-kg person) N/A	Lethal dose for humans No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	100 mL (1570 mg/kg; for a 70-kg person 300-4300 mg/L (average, 2400 mg/L) N/A	Dose believed to be fatal to most adults Ethylene glycol blood concentration in 9 persons who died within 6-48 hours of ingestion unknown amounts of the substance. No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	100 mL/70 kg person (1570 mg/kg) 200 mg/dL N/A	MLD in humans Approximate lethal blood level No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	1-1.5 mL/kg or approximately 100 mL (1100-1650 mg/kg; for a 70-kg person) N/A	Approximate MLD in an adult; plasma half-life is approximately 3-5 hours; in survivors, reported ethylene glycol levels were up to 650 mg/dL, while in fatal cases, levels ranged between 98 to 775 mg/dL. No LD_{50} for rat or mouse
RTECS	398 mg/kg 4700 mg/kg 5500 mg/kg	Human - LD_{Lo} (Subebno-Meditsinskaya Ekspeertiza. Forensic Medical Examination, 26(2), 48, 1983 (as cited in Sax's). This reference is not available for review. Rat – LD_{50} (Bandman et al., 1984); Gigiena Truda i Professional'nye Zabolevaniia. Labor Hygiene and Occupational Diseases, 26(2), 28, 1982 (as cited in Sax's). These references are not available for review. Mouse – LD_{50} (V/O Mezhdunarodnaya Kniga, 1967). This reference is not available for review.

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	1.4 mL/kg of 95% ethylene glycol (reported to be about 1330 mg ethylene glycol/kg body weight)	MLD for human adults (Parry and Wallach, 1974; Robinson and McCoy, 1989; Siew et al., 1975a). Parry and Wallach (1974) reported 100 ml as the estimated lethal dose (source of value not provided) and 2 ml/kg as the approximate lethal dose (citing Brown and Gettler, 1921) in man. Siew et al. also reported 100 ml (or 1.4 ml/kg) as the MLD for adult human (source of value not provided).
	4000 mg/kg	Rat (females) – LD_{50} (Clark et al., 1979). This is a primary source for the value.
	N/A	No LD_{50} for mouse
Clinical Management of Poisoning and Drug Overdose	100 mL (1570 mg/kg; for a 70-kg person)	Lethal dose in human adults; recoveries have been reported following ingestions ranging from 240 to 970 mL (Parry and Wallach, 1974; Wosilat, 1976). Parry and Wallach reported 100 ml as the estimated lethal dose (source of value not provided) and 2 ml/kg as the approximate lethal dose (citing Brown and Gettler, 1921) in man. Wosilat (1976) does not appear to report any values for ethylene glycol.
	200 mg/dL	Approximate lethal level
	N/A	No LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	4700 mg/kg	Rat - LD_{50} (RTECS, 1997)
	5500 mg/kg	Mouse – LD_{50} (RTECS, 1997)

Source	Oral Lethal Dose/Concentration*	Basis
Clinical Toxicology of Commercial Products	100 mL (1570 mg/kg; for a 70-kg person)	Mean lethal dose in human adults (Laug et al., 1939). Laug et al. (1939) cited Hunt (Indust. & Engin. Chem 24, 361, 836, 1932) as the source for this value. Based on two cases, Hunt (1932) suggested that 100 cc. of ethylene glycol would frequently be very near a fatal dose for man.
	6124 mg/kg (5.5 cc./kg)	Rat - LD_{50} (Laug et al., 1939). These authors reported this value in their study on the toxicology of some glycols and derivatives. Smyth et al. (1941) also reported a value of 8540 mg/kg in a commercial preparation that was not chemically pure.
	13.1 cc/kg (14587 mg/kg)	Mouse – LD_{50}. Laug et al. (1939) also reported this LD_{50} value for the mouse.
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans.
	5890 mg/kg	Rat - LD_{50} (Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001). No full reference was given in this secondary source.
	14,600 mg/kg	Mouse - LD_{50} (Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001). This value was cited as from Laug et al., (1936) in the secondary source. The value is confirmed from Laug et al. (1939) study.
Patty's Industrial Hygiene and Toxicology	3180--6360 mg/kg (for a 70-kg person) (200-400 ml)	Lethal dose case reports in humans (Ross, 1956; Tadokaro et al., 1995, all as cited in Patty's). Ross (1956) stated the MLD for ethylene glycol to be between 200 and 400 mL, although recoveries have been observed in cases where as much as 45 g or 240 ml. Ross (1956) is not available for review.
	8000 mg/kg	Mouse - LD_{50} (Plugin, 1968 as cited in Patty's). This reference is not available for review.
Sax's (Lewis R.J.)	8300 (reported as 7500 cm^3/kg	Mouse – LD_{50} (Latven and Molitor, 1939 - J. Pharmacol. Exp. Ther. 65, 89, 1939) (as cited in Sax's). It appeared the value reported by Latven and Molitor (1939) in their study was 7.5 cm^3/kg, corresponding to 8.3 g/kg.

Source	Oral Lethal Dose/Concentration*	Basis
Fenamiphos [22224-92-6]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	N/A 8 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans LD_{50} – experimental animal not specified
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
RTECS	N/A 8 mg/kg 22.7 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (Bulletin of the Entomological Society of America, 1969) (as cited in Sax's). This reference is not available for review. Mouse – LD_{50} (Perkow et al. 1976) (as cited in Sax's). This reference is not available for review.
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	2.7 mg/kg (male); 3.0 mg/kg (female)	Rat - LD_{50} (male). (U.S. EPA/Office of Pesticide Programs; Interim Reregistration Eligibility Decision Document - Fenamiphos. EPA 738-R-02-004 May 2002. The primary source for this value is Lamb and Matzkanin (1975); but reference unavailable for review.
	4.9 mg/kg (female)	Rat - LD_{50} (International Programme on Chemical Safety's Pesticide Data Sheets (PDS). Kimmerle, 1972c; Crawford and Anderson, 1974; DuBois et al., 1967. These references have not been retrieved.
	8.3-22.7 mg/kg	Mouse - LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 1635). (Bulletin of the Entomological Society of America, 1969; Perkow et al. 1976) (as cited in Sax's). WHO cited Löser and Kimmerle (1971) as the source of 22.7 mg/kg for male mouse, while WHO/FAO (DATA SHEET ON PESTICIDES No. 92) did not cite the source for the 8.3 mg/kg value for female mice.
Patty's Industrial Hygiene and Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans.
	2-100 mg/kg	Reported range of oral animal LD_{50} values from unpublished company studies (Bayer as cited in Patty's). Individual study results were not specified in this secondary source.
Geosmin (trans, trans-1, 10-dimethyl-9-decalol) [19700-21-1]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
RTECS	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Mercuric Chloride [7487-94-7]		
Handbook of poisoning	10.3 mg Hg^{2+}/kg (1000 mg $HgCl_2$) N/A	Fatal dose in humans. The source of the values was not reported. No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	10.3 mg Hg^{2+}/kg (14 mg/kg) (1000 mg inorganic mercuric salts) 22 mg/L and 0.8 mg/L (as $HgCl_2$) N/A	Average lethal dose; forms of salts not specified; we assumed $HgCl_2$. Blood concentrations reported in 2 adults who died 2 hours and 8 days, respectively, after ingesting large amounts of $HgCl_2$; dose not reported (Klenshoj and Rejent, 1966; Steentoft, 1968) No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Handbook of Emergency Toxicology	5.3 mg Hg^{2+}/kg (500 mg $HgCl_2$)	Approximate MLD in humans; no source was provided.
	0.04 mg/L (as mercury inorganic)	Characterized as highly toxic or lethal concentration; authors stated value can vary widely depending upon many factors
	N/A	No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans
	0.022 mg/L	Whole blood concentration of mercury associated with death (Timberlake, 1984)
	N/A	No LD_{50} for rat or mouse
RTECS	10.3 mg Hg^{2+}/kg (14 mg/kg $HgCl_2$)	Human; man - LD_{Lo} (Gekkan Yakuji, Pharmaceuticals Monthly, 1999, Vol. 41, p. 2383; Handbook of Pesticide Toxicology, Robert Krieger ed, 2001, Vol. 2, p. 1371). Reference is not available for review.
	0.7-3.7 mg Hg^{2+}/kg (1-5 mg/kg $HgCl_2$)	Rat – LD_{50} (The Pesticide Manual, The British Crop Protection Council (BCPC), 1991, Vol. 9, p. 550; Gigiena Truda i Professional'nye Zabolevaniia. Labor Hygiene and Occupational Diseases, 25(7), 27, 1981 (as cited in Sax's). The 10th edition of The Pesticide Manual reported the oral LD_{50} of 1-5 mg/kg; the range is reported here.
	4.4 mg Hg^{2+}/kg (6 mg/kg $HgCl_2$)	Mouse – LD_{50} (Gigiena I Sanitariya, 1986, Vol. 51(1), p. 76) (as cited in Sax's). This reference is not available for review.
ATSDR	10-42 mg Hg^{2+} /kg (as $HgCl_2$)	Estimated lethal dose of $HgCl_2$ in human adult (Gleason et al., 1957). This reference is not available for review.
	37 mg Hg^{2+}/kg (as $HgCl_2$)	Rat - LD_{50} (Kostial et al., 1978). Kostial et al. reported LD_{50} values of 50 mg $HgCl_2$/kg for older (>18-week old) female rats versus 92, 105, and 35 mg $HgCl_2$/kg for 6-week (both sexes), 3-week (both sexes), and 2-week (female) rat. Based on these results, the preferred value is 50 mg $HgCl_2$/kg (corresponding to 37 mg Hg^{+}/kg).
	N/A	No LD_{50} for mouse

Source	Oral Lethal Dose/Concentration*	Basis
Clinical Management of Poisoning and Drug Overdose	10.3-42 mg Hg^{2+}/kg (14-57 mg $HgCl_2$/kg (for a 70-kg person) (1000 - 4000 mg (as $HgCl_2$) N/A	Lethal dose for an adult; as little as 500 mg found to cause fatality No LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
NIOSH	N/A 155 mg Hg^{2+}/kg (210 mg of $HgCl_2$/kg) N/A	No LD_{Lo}, MLD, or lethal dose for humans Rat - LD_{50} (Worthing 1991); reference no available for review. No LD_{50} for mouse
ATLA – Alternatives to Laboratory Animals	N/A 0.74 mg Hg^{2+}/kg (1 mg/kg $HgCl_2$) 4.4 Hg^{2+}/kg (6 mg/kg $HgCl_2$)	No LD_{Lo}, MLD or lethal oral dose reported for humans Rat – LD_{50} (RTECS 1977) Mouse – LD_{50} (RTECS 1977)
Clinical Toxicology of Commercial Products	10.3 mg Hg^{2+}/kg (1000 – 4000 mg; 14 mg/kg for a 70-kg person) N/A	Lethal dose for human adult; no reference given in this secondary source. No LD_{50} for rat or mouse
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Patty's Industrial Hygiene and Toxicology	21 mg Hg^{2+}/kg (2 g or 29 mg/kg $HgCl_2$ for a 70-kg person)	Reported as "expected to increase mortality greatly" in secondary source; no reference given.
Sax's (Lewis R.J.)	21-64 mg Hg^{2+}/kg (29-86 mg/kg $HgCl_2$)	LD_{Lo} for humans (New England J. Med. 244, 459, 1981; J. Toxicol. Clin. Toxicol. 26, 189, 1988) (as cited in Sax's).
Sauder et al. (1988)	63.3 mg Hg^{+}/kg (for a 70-kg person)	Lethal dose in a 27-year old man who ingested 6 g of mecury chloride. Plasma concentration of 5 mg/L was observed on admission; patient died on the 91st day after 42 hemodialyses and 6 plasma exchanges.

Source	Oral Lethal Dose/Concentration*	Basis
Methamidophos [10265-92-6]		
Handbook of poisoning	N/A 19 mg/kg	No LD_{Lo}, MLD or lethal oral dose reported for humans Unspecified experimental animal
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
RTECS	N/A 7.5 mg/kg 20 mg/kg	No LD_{Lo}, reported for humans Rat – LD_{50} (Agricultural Research Service, USDA Information Memorandum, 1966, Vol. 20, p.7) (as cited in Sax's). This reference is not available for review. Mouse – LD_{50} (Kao and Fukuto (1977). Pesticide Biochemistry and Physiology, 1977, Vol. 7, p. 83). The authors cited Magee (Residue Rev. 53:3, 1974) as the source for this value. Magee (1974) reported a value of 20 mg/kg, not 14 mg/kg as reported by RTECS.
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	NA 1 mg/kg 6 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – $LD_{50;}$ RTECS was cited as the source, but this value was not reported in RTECS (see above). Mouse – $LD_{50;}$ RTECS was cited as the source, but this value was not reported in RTECS (see above).

Source	Oral Lethal Dose/Concentration*	Basis
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	N/A 20-27 mg/kg 20 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1063). Kao and Fukuto (1977) cited Magee (Residue Rev. 53:3, 1974) as the source for an LD_{50} value of 20 mg/kg for the rat. Mouse – LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 1357). Kao and Fukuto (1977) cited Magee (Residue Rev. 53:3, 1974) as the source for the LD_{50} value of 14 mg/kg for the mouse.
Methyl parathion [298-00-0]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	N/A 10 mg/kg	No LD_{Lo}, MLD or lethal oral dose reported for humans Lethal dose in experimental animal; species not specified
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
RTECS	N/A 6 mg/kg 17.8 mg/kg	No LD_{Lo}, MLD or lethal oral dose reported for humans Rat – LD_{50} (Marhol, 1986). This reference is not available for review. Mouse – LD_{50} (Human and Environmental Toxcicology, 1992). Sax's also reported a value of 18 mg/kg and cited Bratislavska Lekarke Listy 38:151, 1958.

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	26 mg/kg (estimated dose of 1.84 g and assuming 70-kg body weight)	Human - LD_{Lo} 50-year old male ingested Wofatox liquid; estimated methyl parathion dose reported in ATSDR summary was 1840 mg (Fazekas and Rengei, 1964 as cited in ATSDR). This reference is not available for review.
	4-9 mg/kg (307-660 mg)	MLD for human adults. Fazekas and Rengei (1964 as cited in ATSDR) reported lethal oral doses ranging from 307 to 660 mg for adults. In a series of case studies in adults, 26 individuals died after ingesting between 50-300 g Wofatox (Fazekas, 1971 as cited in ATSDR). This reference is not available for review.
	12-24.5 mg/kg (assumed technical formulation used)	Rat - LD_{50} (EPA 1978e; Gaines 1969; Miyamoto et al. 1963b). In the study by Gaines (1969), LD_{50} values of 14 and 24 mg/kg were reported in male and female rats, respectively. Miyamoto et al. is a primary source for the LD_{50} value of 24.5 mg/kg for methyl parathion synthetic product. EPA (1978e) is not available for review.
	12.4 mg/kg	Mouse – LD_{50} (El-Herrawie and El-Sayed, 1986; Miyamoto et al., 1963). The values of 10.3 and 12.4 mg/kg were from studies conducted by El-Herrawie and El-Sayed using emulsifiable concentrate and technical formulation, respectively. Miyamoto et al. is a primary source for the LD_{50} value of 17 mg/kg for the synthetic product. Recommended value is 12.4 mg/kg for the technical formulation.
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	6 mg/kg (male); 30 mg/kg (female)	Rat - LD_{50} (Worthing, C.R. and S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 8th ed. Thornton Heath, UK: The British Crop Protection Council, 1987., p. 635). The 10th edition of The Pesticide Manual lists the values as 6 mg/kg and 30 mg/kg for males and females, respectively. Therefore, these values are substituted for the corresponding 14 and 24 mg/kg as reported in HSDB.
	N/A	No LD_{50} for mouse
Patty's Industrial Hygiene and Toxicology	5-10 mg/kg	Estimated MLD in humans, cited from ATSDR, 1992. However, an updated ATSDR profile is available (ATSDR, 2001). A published survey of case reports with doses unspecified in the secondary source text was cited (Fazekas, 1971 – see ATSDR above).
	8-24 mg/kg	Rat - LD_{50}. range of value reported in the following references (Deichmann et al., 1952; Gaines, 1960; Warden et al., 1973; Haley et al., 1975 all as cited in Patty's)
MIB (2-Methylisoborneol) [2371-42-8]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
RTECS	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Microcystin-LR [101043-37-2]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
RTECS	N/A >5 mg/kg 5 mg/kg	No LD_{Lo}, reported for humans Rat – LD_{50} (Fawell et al. (1999) - Human & Experimental Toxicol. 18:162-167. This is a primary source for the value; the LD_{50} was >5mg/kg.. Mouse – LD_{50} (Fawell et al. (1999) - Human & Experimental Toxicol. 18:162-167. this is a primary source for the value.
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, reported for humans; no LD_{50} for rat or mouse
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Nicotine [54-11-5]		
Handbook of poisoning	40 mg (0.6 mg/kg; pure nicotine) N/A	Fatal dose in humans No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	40-60 mg (0.6 mg/kg nicotine) 11-63 mg/L (average: 29 mg/L) N/A	Estimated MLD in man Post-mortem blood concentrations in 5 adults who swallowed 20-25 g of nicotine sulfate solution; individuals died within 1 hour; time of analysis not indicated. No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	50 mg (0.7 mg/kg; nicotine, for 70-kg person) 0.5 mg/L N/A	MLD for humans Characterized as highly toxic or lethal concentration; authors stated value can vary widely depending upon many factors No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	40-60 mg (0.6-0.9 mg/kg; nicotine) N/A	Dose likely to be lethal; survival reported following ingesting 1- 4 g (Franke and Thomas, 1936). The authors only cited Sollman (1926) who reported 65 mg nicotine (corresponding to 0.9 mg/kg) as the minimal fatal dose and a case of recovery following ingestion of 4 g of pure nicotine. No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
RTECS	0.9 mg/kg (nicotine) (60 mg)	Human MLD (Arena – Poisoning; Toxicology Symptoms, Treatments, 1970, Vol. 2, p. 73) (as cited in Sax's). A value of 60 mg was reported as the MLD for a 150-lb person, but no reference given in this secondary source.
	50 mg/kg (nicotine)	Rat - LD_{50} (Farm Chemicals Handbook, 1991, p. C219 (as cited in Sax's). Lazutka et al. (1969) also reported values of 52.5 mg/kg for nicotine and 56.7 mg/kg for nicotine sulfate in their study.
	3.34 mg/kg (nicotine)	Mouse – LD_{50} (Lazutka et al. 1969; Hygiene and Sanitation, 1969, Vol. 34(4-6), p. 187) (as cited in Sax's). These authors reported values of 3.34 mg/kg for nicotine and 8.55 mg/kg for nicotine sulfate in their study.
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	30-60 mg (0.4-0.9 mg/kg; nicotine)	Estimated "lethal" dose in humans; survival reported following ingestions of 2 and 4 g (Franke and Thomas, 1936). Franke and Thomas (1936) reported 65 mg nicotine (corresponding to 0.9 mg/kg) as the minimal fatal dose and a case of recovery following ingestion of 4 g of pure nicotine (citing Sollman (1926). However, Sollman (1926) is not available for review.
	N/A	No LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	60 mg (0.9 mg/kg of the base form of nicotine)	Probable acutely fatal dose for an adult
	N/A	No LD_{50} for rat or mouse
NIOSH	50-60 mg (0.7-0.9 mg/kg; nicotine)	Estimated fatal human (Lazuka et al., 1969). This reference is not available for review.
	50 mg/kg (nicotine)	Rat – LD_{50} (Sine, 1993). This reference is not available for review.
	3.34 mg/kg (nicotine)	Mouse – LD_{50} (Franke and Thomas, 1932). A review of the article did not confirm this value in the mouse; the study was conducted in dogs. However, Lazutka et al. (1969) reported this value from their study.

Source	Oral Lethal Dose/Concentration*	Basis
ATLA – Alternatives to Laboratory Animals	N/A 50 mg/kg 3.34 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} Mouse – LD_{50}; see RTECS above, which is the source of ATLA numbers.
Clinical Toxicology of Commercial Products	30-60 mg (0.4-0.9 mg/kg for a 70-kg person)	Estimated lethal dose for humans
HSDB	60 mg (0.9 mg/kg of the base form of nicotine) 50-60 mg/kg 24 mg/kg	Fatal dose for an adult human [Hardman, J.G., L.E. Limbird, P.B. Molinoff, R.W. Ruddon, A.G. Goodman (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 9th ed. New York, NY: McGraw-Hill, 1996., p. 193]. No reference was given in this secondary source (see above). Rat – LD_{50} [Klaassen, C.D., M.O. Amdur, Doull J. (eds.). Casarett and Doull's Toxicology. The Basic Science of Poisons. 5th ed. New York, NY: McGraw-Hill, 1995., p. 669]. Although not cited in HSDB, Lazutka et al. (1969) reported and LD_{50} value of 52.5 in their study. Mouse – LD_{50} (Hayes, W.J., Jr., E.R. Laws, Jr., (eds.). Handbook of Pesticide Toxicology. Volume 2. Classes of Pesticides. New York, NY: Academic Press, Inc., 1991., p. 604).
Patty's Industrial Hygiene and Toxicology	0.9 mg/kg (for a 70-kg person) (60 mg) 50-60 mg/kg N/A	Human lethal dose. No reference was given in secondary source. Rat – LD_{50} (Lehman, 1951 as cited in Patty's). This reference is not available for review. Mouse – LD_{50} A range of 50-60 mg/kg. However, only approximate lethal dose of 8 mg/kg was reported for the mouse following intramuscular injection from cited reference (Feurt et al, 1958).
Gaines (1960)	32 mg nicotine/kg (83 mg/kg nicotine sulfate)	Rat – LD_{50}. Gaines (1960) reported this value for female rats in his study.
Pesticide Dictionary (1997)	50-60 mg nicotine/kg	Rat – LD_{50}. No source was provided for the value.

Source	Oral Lethal Dose/Concentration*	Basis
Oxamyl [23135-22-0]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	N/A 5 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans LD_{50} – experimental animal not specified
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
RTECS	N/A 2.5 mg/kg 2.3 mg/kg	No LD_{Lo}, MLD or lethal oral dose reported for humans Rat - LD_{50} (Kennedy, 1986 - Fundamental and Applied Toxicology, 1986, 6:423) (as cited in Sax's). See below. Mouse – LD_{50} (Kennedy, 1986 - Fundamental and Applied Toxicology, 1986, 6:423) (as cited in Sax's). See below.
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
HSDB	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans
	2.5-5.4 mg/kg	Rat – LD_{50} (Hayes, Wayland J., Jr. Pesticides Studied in Man. Baltimore/London: W illiams and Wilkins, 1982, p. 457; Tomlin CDS, ed. oxamyl (23135-22-0). In: The Pesticide Manual, Version 2.2 (2002). Surrey UK, British Crop Protection Council). Kennedy (1986) reported LD_{50} value of 2.5-3.1 mg/kg in his study conducted on 24-hour fasted rats, which were observed for up to 14 days following exposure. The Pesticide Manual also reported a value of 5.4 mg/kg, citing Pesticide Residues in Food (1986) as the source.
	2.3-3.3 mg/kg	Mouse – LD_{50}. Kennedy (1986) reported LD_{50} values of 3.3 mg/kg (males) and 2.3 mg/kg (females) in fasted animals.
Paraquat (paraquat dichloride) [1910-42-5]		
Handbook of poisoning	2.9 mg paraquat/kg (4 mg/kg paraquat dichloride)	Estimated fatal dose for humans
	87 mg paraquat/kg (120 mg/kg paraquat dichloride)	Rat – LD_{50}. LD_{50} range of 200-300 mg/kg has also been reported for rats; however, no references were given in this secondary source.
	N/A	No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	10-20 mg paraquat/kg (1000-2000 mg or 14-28 mg/kg of paraquat dichloride for a 70-kg person)	Dose believed to be fatal oral dose to most adults; assumed to be paraquat dichloride
	0-63 mg/L (average, 15 mg/L)	Blood level in 9 fatal cases; individuals lived only up to 1 day after ingestion of paraquat; individuals living longer before succumbing had lower blood levels
	N/A	No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Handbook of Emergency Toxicology	0.8 mg paraquat/kg (75 mg/70 kg person, as paraquat dichloride) 20 mg/L (assumed to be the concentration for paraquat) N/A	MLD for humans; no reference given in this secondary source. Lethal blood concentration, probably associated with the MLD No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	31-63 mg paraquat/kg (3000-6000 mg or 43-86 mg/kg paraquat dichloride; for 70-kg person) N/A	Lethal dose range for humans No LD_{50} for rat or mouse
RTECS	0.65-31 mg paraquat/kg (0.9-43 mg/kg paraquat dichloride) 41 mg paraquat/kg (57 mg/kg paraquat dichloride) 120 mg paraquat/kg	Human – male (LD_{Lo}) [Nippon Byori Gakkai Kaishi. Journal of the Japanese Pathological Society. (c/o Tokyo Daigaku Igakubu Byorigaku Kyoshitsu, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113, Japan) V.1- 1911- Volume(issue)/page/year: 70,118,1981]; British Medical Journal (British Medical Asso., BMA House, Tavistoxk Sq.' London WC1H 9JR, UK) V.1- 1857- Vloume(Issue)/page/year:3, 396,1978; Archives of International Medicine (AMA, 535 N. Dearborn St., Chicago, IL 60610) V.1- 1908- Volume (issue)/page/year: 146,681,1986. Rat – LD_{50} cited from Magee (Residue Reviews, 1965, Vol. 10, p. 97, 1965) (cited in Sax's). This reference is not available for review. Mouse – LD_{50} (Matkovics et al., 1975 - General Pharmacology. (Pergamon Press Inc., Maxwell House, Fairview Park, Elmsford, NY 10523) V.6- 1975- Volume(issue)/page/year: 12,225,1981) (cited in Sax's). Review of Matkovics et al. study indicates that these authors were not the primary source for the LD_{50}; however, the 120 mg/kg reported referred to the active ingredient
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Clinical Management of Poisoning and Drug Overdose	22 mg paraquat/kg (30 mg/kg or 50 ml of paraquat concentrate)	Death may occur within several hours to a few days resulting from multiple organ failure; no reference was provided, and assumed the concentrate was the dichloride for calculation.
	3.6 mg paraquat/kg (4 ml/kg or 5 mg/kg; paraquat concentrate)	Increases likelihood of death (no reference given).
	30 mg paraquat/kg (based on lethal dose of 10 mL of 20% solution)	No survivors if plasma concentration > 3 mg/L (Hampson and Pond, 1988). Authors reported that ingestion of as little as 10-20 ml of a 20% solution of paraquat concentrate can cause death and that 5-10% of an oral dose is absorbed. The paper compiled data from literature reports (35 patients) and case records (7 patients). Adequate information on pretreatment plasma paraquat concentrations was available for these patients and analysis of the results indicated fatality if blood level >3 mg/L
	N/A	No LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	41 mg paraquat/kg (57 mg paraquat dichloride/kg	Rat – LD_{50} (Bailey and White, 1965). This reference was a compilation of LD_{50} and other values for organic herbicides; source of value not provided.
	120 mg paraquat/kg	Mouse – LD_{50} (Barabas et al., 1981). These authors cited Matkovics et al. (1980a) as the source of the mouse LD_{50} value. Review of Matkovics et al. study indicates that these authors were not the primary source for the LD_{50}; however, the 120 mg/kg reported referred to the active ingredient.

Source	Oral Lethal Dose/Concentration*	Basis
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	41mg paraquat/kg (57 mg/kg paraquat dichloride)	Rat – LD_{50}. Since RTECS is the source for ATLA values, the 100 mg/kg reported by ATLA has been replaced with the RTECS value of 57 mg/kg paraquat dichloride (see above).
	120 mg/kg paraquat	Mouse – LD_{50}. See RTECS above.
Clinical Toxicology of Commercial Products	22 mg paraquat/kg (30 mg/kg or 50 ml of paraquat concentrate)	Death may occur within hours to a few days resulting from multiple organ failure; no reference was provided, and we assumed the concentrate was the dichloride.
	N/A	No LD_{50} for rat or mouse
HSDB	25 paraquat/kg (35 mg/kg, assumed to be for paraquat dichloride)	MLD for humans (WHO; Environ Health Criteria: Paraquat and Diquat p.76 (1984). This estimate is by Pederson et al. (1981 as cited in WHO, 1984) and Bismuth et al. (1982 as cited in WHO, 1984). Some patients have survived after apparently ingesting 50 - 100 ml Gramoxone$^{(R)}$ (10 - 20 g paraquat) (whereas some died after taking as little as 2 sachets of Weedol (2.5 g paraquat) (reference for lethal case not specified in secondary source (WHO, 1984). Bismuth et al. (1982) reported estimated MLD of paraquat to be about 35 mg/kg (citing Pasi, 1978).
	112-147 mg paraquat/kg (155-203 mg paraquat dichloride/kg)	Rat – LD_{50} (Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983., p. 943). An updated edition of Verschueren (2001) lists an oral LD_{50} range in various mammalian species as 30-112 mg/kg based on Clark et al., (1966 as cited in Verschueren, 2001), however, based on WHO, 1984 these lower values were for the cat and guinea pig. Clark et al. (1966) is not available for review.
	71 mg paraquat/kg (98 mg/kg (paraquat dichloride)	Mouse – LD_{50} (Hayes, W.J., Jr., E.R. Laws, Jr., (eds.). Handbook of Pesticide Toxicology. Volume 3. Classes of Pesticides. New York, NY: Academic Press, Inc., 1991., p. 1358)

Source	Oral Lethal Dose/Concentration*	Basis
Patty's Industrial Hygiene and Toxicology	46-50 mg paraquat/kg (100-200 mg/kg as paraquat dimethylsulfate)	Rat – LD_{50} (range of values cited from WHO, 1984). The lower end of this range was reported as 100 mg/kg in female and 110 mg/kg in male rats (Kimbrough and Gaines, 1970 as cited in WHO, 1984). Kimbrough and Gaines (1970) is a primary source that reported LD_{50} values of 100 mg/kg and 110 mg/kg for paraquat dimethylsulfate paraquat in male and female rats, respectively, in their study.
Sax's (Lewis R.J)	31-155 mg paraquat/kg (43-214 mg/kg paraquat dichloride)	Human LD_{Lo} (YKYUA6 30, 985, 1979; BMJOAE 2, 396, 1978).
Pentachlorophenol [87-86-5]		
Handbook of poisoning	14 mg/kg (1000 mg) for a 70-kg person 46 µg/mL N/A	Fatal dose in humans; no source was provided for the value. Serum level quoted for the above fatal dose No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	28 mg/kg (2000 mg) 39 mg/L 46-173 mg/L (average, 107 mg/L) N/A	Fatal dose in an adult. This same value was reported as the lethal dose in man (Clarke 1969), but no reference was provided. Blood concentration measured in an adult who ingested 11 g and died within 4 hours (Burger, 1966) Blood concentrations from 7 fatalities resulting from pulmonary, oral, or dermal exposure to pentachlorophenol; no documentation of dose available (Gordon, 1956; Blair, 1961; Mason et al., 1965; Clarke, 1969; Cretney, 1976; Gray et al., 1985). Gordon reported blood level of 5 mg/100ml in a victim. The exact amount of pentachlorophenol consumed by the victims was not reported by Blair (1961). All two fatal cases reported by Mason et al. and one by Gray et al. were from inhalation exposures. No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans
	4 mg/dL	Highly toxic or lethal blood level
	N/A	No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	28 mg/kg (2000 mg)	Not a fatal dose; dose described as producing severe toxic effects in adults
	N/A	No LD_{50} for rat or mouse
RTECS	401 mg/kg	Human - LD_{Lo} (Ecotoxicology and Environmental Safety 1977, Vol. 1, p. 343). This reference is not available for review.
	77.9 mg/kg	Rat – LD_{50} (Deichmann et al., 1942 - J. Pharmacol. Exper. Ther., 1942, Vol. 76, p. 104). Note that due to the toxicity of the solvent (fuel oil) other LD_{50} values may be more appropriate (comment from Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)). Deichmann et al., (1942) reported values of 27.3 mg/kg for 0.5-% pentachlorophenol in Stanolex fuel oil, and 77.9 mg/kg for 1% in olive oil in their study.
	30 mg/kg	Mouse – LD_{50} (Vrednie chemichescie veshestva, 1994, p. 246). This reference is not available for review.

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	14 mg/kg (1000 mg; unspecified purity) 120 mg/kg 117-177 mg/kg (99% pure)	Human – estimated LD_{Lo} (Driesbasch, 1980). Rat – LD_{50} (St. Omer and Gadusek, 1987). This is a primary source, and values of 50 mg/kg, 120 mg/kg, and 80 mg/kg were reported for 10 to 20-day, 10-week, and 19-week old rats, respectively. The 120 mg/kg value for the young adult is preferred to the values from younger and older animals. Mouse – LD_{50} (Borzelleca et al., 1985. This is a primary source for the LD_{50} value ; vehicle used was 10% Emulphor. Note that lower mouse values (36-48 mg/kg) were reported, but used high concetrations of ethanol (40%) as the vehicle (Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001).
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
NIOSH	N/A	Reported MLD in humans (Haley, 1977). The author reported a fatal case involving a 71-year-old male who ingested an estimated 4-8 oz of weed killer containing 12% pentachlorophenol, 1.5% other chlorinated phenols, 82% aromatic petroleums (AR55), and 4.5% inert ingredient; therefore, the death cannot be attributed to pentachlorophenol alone, and the value of 410 mg/kg reported by NIOSH is excluded from this analysis.
	150 mg/kg	Rat – LD_{50} (Deichmann et al., 1942); cited Kehoe et al. (1939) as source of the LD_{50} value of 27.3 mg/kg. Kehoe et al. conducted their study on rabbits, not rats; hence value was deleted from the table, but was replaced with a value of 150 mg/kg (Fielder RJ, Sorrie GS, Bishop CM, Jones RB, Van Den Heuval MJ [1982]. Pentachlorophenol toxicity review 5. London, England: Health and Safety Executive, Her Majesty's Stationery Office). However, Fielder et al. ss not available for review.
	117 mg/kg	Mouse – LD_{50} (Borzelleca et al., 1985). See Pederson et al. (1981 as cited in WHO, 1984) and Bismuth et al. (1982 as cited in WHO, 1984e)
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	27 mg/kg	Rat – LD_{50} (see comments for studies above regarding solvent effect – value not selected as lowest rat value)
	36 mg/kg	Mouse – LD_{50} (see comments for studies above regarding solvent effect – value not selected as lowest mouse value)
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	23 to 162 mg/L	Serum levels reported in cases of fatal overexposure (Ryan, R.P., C.E. Terry (eds.). Toxicology Desk Reference 4th ed. Volumes 1-3. Taylor & Francis, washington, D.C. 1997., p. 1909)
	146 mg/kg (male); 175 mg/kg (female)	Rat – LD_{50} (Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989., p. 1126)
Clarke (1969)	10.3%	Pentachlorophenol blood level in a fatal poisoning case; however, the reference cited, Jackson 1967, was a personal communication.
	78-200 mg/kg	Rat – LD_{50}; however, no reference was given for the range of values.
Sax's (Lewis R.J.)	401 mg/kg	Human LD_{Lo} (Ecotoxicol. Environ. Safety 1, 343, 1977). This reference is not available for review.
Permethrin [52645-53-1]		
Handbook of poisoning	430 mg/kg	LD_{50} in experimental animal(s); species not specified
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse. Note that this reference quotes a value of >1000 mg/kg as estimated lethal dose of pyrethrum in humans, although a value is not given for the synthetic pyrethrum product – permethrin.

Source	Oral Lethal Dose/Concentration*	Basis
RTECS	N/A	Human – LD_{50} of greater than 4000 mg/kg; route of exposure not reported – we assumed oral exposure (Defense des Vegetaux. (Federation Nationale des Groupements de Protection des Cultures, 149, rue de Bercy, 12, France) V.1-1947- Volume 32, Issue 168, 1978). Due to uncertainties and report of greater than 4000 mg/kg, this value was not considered reliable.
	383 mg/kg	Rat – LD_{50} (National Technical Information Service (Springfield VA 22161). AD-A047-284). This reference is not available for review.
	424 mg/kg	Mouse – LD_{50} (Williamson et al., 1989 -Ecotoxicology and Environmental Safety - Academic Press, Inc., 1 E. First St. Duluth, MN 55802 – Volume 18, Issue 27, 1977). This is a primary source for the value; the authors did not observe any differences in toxicity of technical-grade permethrin (95.1% pure) and a formulated product (minimum 35% (±) *cis*/maximum 65% (±) *trans*).
ATSDR	383 mg/kg	Rat – LD_{50} (DOD 1977). Note that the reported rat oral LD_{50} values range from 383 mg/kg to 4892 mg/kg.
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse. Note that this reference also quotes 1000-2000 mg/kg as human fatal oral dose for naturally occurring mixture of pyrethrins and 260-420 mg/kg as rat LD_{50} for pyrethrin. These values were not used since permethrin is a synthetic pyrethrin.

Source	Oral Lethal Dose/Concentration*	Basis
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	410 mg/kg /AI dissolved in an unsaturated oil (female)	Rat - LD_{50}. (Hayes, Wayland J., Jr. Pesticides Studied in Man. Baltimore/London: Williams and Wilkins, 1982., p. 81). The rat oral LD_{50} values range from 410 mg/kg to 6000 mg/kg, which appears to depend to some degree on vehicle. LD_{50} values for dosing in lipohillic solvents are lower than when dissolved in water. Thus, the selected value may be conservative.
	250-500 mg/kg in DMSO (male and female)	Mouse - LD_{50} (WHO; Environmental Health Criteria 94: Permethrin p.64 (1990). The mouse LD_{50} values range from 250 mg/kg to >4000 mg/kg – depending on solvent used. Value was obtained from Clark (1978), Toxicology of WL 43479: acute toxicity of WL43479, Sittingbourne, Shell Research Ltd (Report No. TLGR. 0043.78) (Unpublished data submitted to WHO).
Sax's (Lewis R.J)	85-107 mg/kg	Rat – LD_{50} for (+)-cis permethrin for female and males (Miyamoto, 1976 - Environ. Health Persp. 14, 15, 1976). Miyamoto, a secondary source, reported LD_{50} values of 85 mg/kg and 107 mg/kg for (+)-cis permethrin in female and male rats, respectively. The racemic form and (+)-trans permethrin have values of 490 mg/kg and ≥3100 mg/kg; the (-)-cis and (-)-trans forms have values >5000 mg/kg.
	>5000 mg/kg	Mouse - LD_{50} for racemic mixture of permethrin. (Miyamoto, 1976 - Environ. Health Persp. 14, 15, 1976)
Phenol [108-95-2]		
Handbook of poisoning	2000 mg (28 mg/kg)	Human fatal dose; no other information given.
	N/A	No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD, or fatal dose reported for humans
	46 mg/L	Post-mortem blood concentration in a fatal case involving a man who drank Lysol in a suicidal gesture (Briglia, 1981)
	N/A	No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Handbook of Emergency Toxicology	10 mL (151 mg/kg) N/A	MLD in humans No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	10-30 g (143-429 mg/kg) N/A	Estimated lethal oral dose in humans; stated that fatalities have occurred after ingesting as little as 4.8 g (Haddad, Dimond, and Schweistris, 1979). These authors reported a case study in which they stated a patient recovered from ingesting 26.7 g of phenol, a dose they described as 3-10 times the lethal dose (citing Gosselin et al., 1976 and Arena (1974). The cited references do not appear to be primary references. Baker et al. (1978) also reported the 10-30 g fatal dose, but gave no reference to the range of values. No LD_{50} for rat or mouse
RTECS	140 mg/kg (for 70-kg person) (10-20 g) 14-143 mg/kgfor a 70-kg person (1000-10000 mg/kg) 317 mg/kg 270 mg/kg	Human - LD_{Lo} (Lefaux, 1968 - Practical Toxicology of Plastics, 1968, p. 329). Lefaux (1968) indicated that 10-20 g of phenol are fatal; no source was provided. Human infant – LD_{Lo} (Deichmann and Gerarde, 1969 – Toxicology of Drugs and Chemicals, 1969, p. 463). This secondary source reported 1-10 g as the lethal oral doses of phenol for adults, but gave no reference. Rat – LD_{50} (Proceedings of the Society for Experimental Biology and Medicine, 1935, Vol. 32, p. 592). This reference is not available for review. Mouse – LD_{50} (Gigiena i Sanatayira, 1973, Vol. 38, p. 6). This reference is not available for review.

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	14-930 mg/kg (based on range of 1 – 65 g phenol for 70 kg person)	Range of fatal doses in humans; other case reports indicated values within this range (Deichmann and Klepinger, 1981; Bruce et al., 1987; Stajduhar-Cariac (1968). Deichmann and Klepinger summarized data from literature and indicated 1 g of phenol could be fatal in humans, but some patients survived doses as high as 65 g. Bruce et al. estimated 140 mg/kg from numerous case reports to be the minimal dose at which death occurs. Stajduhar-Cariac reported a case in which a woman ingested about 10-20 g of phenol (approximately 172 mg/kg for a 58-kg body weight) and died within hours.
	340-650 mg/kg	Rat – LD_{50}; LD_{50} values decreased with increasing concentration of phenol in the gavage fluid (Deichmann and Witherup, 1944; Berman et al. 1995; Flickinger, 1976). Deichmann and Witherup (1944) reported values of 340 mg/kg for a 20-% emulsion, and 530-540 mg/kg for 2-10% aqueous phenol solutions in their study. Berman et al. (1995) reported a value of 400 mg/kg in their study. Flickinger (1976) reported LD_{50} value of 650 mg/kg in a study conducted in male albino rats.
	300 mg/kg	Mouse – LD_{50} (von Oettingen and Sharpless, 1946). This is a primary source for the value.
Clinical Management of Poisoning and Drug Overdose	3000-6000 mg (43-86 mg/kg)	Lethal oral dose in humans
	N/A	No LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	14-140 mg/kg (for a 70-kg person)	Lethal oral dose range for humans (Deichman and Gerarde, 1969); not a primary source of value and also gave no reference for the value.
	317 mg/kg	Rat – LD_{50} (Brown and Lamson, 1935). The article we have in hand referenced another paper by the authors that may be the source of this value.
	270 mg/kg	Mouse – LD_{50} (Korolev et al., 1973). This reference is not available for review.

Source	Oral Lethal Dose/Concentration*	Basis
ATLA – Alternatives to Laboratory Animals	N/A 317 mg/kg 270 mg/kg	No LD_{Lo}, MLD, or lethal dose in humans Rat – LD_{50} Mouse – LD_{50}
Clinical Toxicology of Commercial Products	3000-6000 mg (43-86 mg/kg for a 70-kg person)	Lethal oral dose in humans
HSDB	50-500 mg/kg 530 mg/kg 270 mg/kg	Probable oral lethal dose to humans Rat – LD_{50} (O'Neil, M.J. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. 13th Edition, Whitehouse Station, NJ: Merck and Co., Inc., 2001., p. 1299) Mouse – LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 2630)
Patty's Industrial Hygiene and Toxicology	140 mg/kg 340-530 mg/kg	"Estimated to be the minimal human oral dose at which death occurs" (Bruce et al, 1987). Bruce et al. estimated 140 mg/kg from numerous case reports to be the minimal dose at which death occurs. Rat – LD_{50} (Deichmann and Witherup, 1944 as cited in Patty's)
Arsenic (sodium arsenite) [7784-46-5]		
Handbook of poisoning	1.3 mg As^{3+}/kg 120 mg (As_2O_3) 1-15 µg/mL N/A	Human fatal dose Blood level in fatal arsenic poisoning; form of arsenic not specified No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Disposition of Toxic Drugs and Chemicals in Man	2.2 mg As^{3+}/kg (200 mg as As_2O_3)	Human fatal dose
	0.6-9.3 mg As^{3+}/L (3.3 mg/L, average)	Blood arsenic concentration based on 49 fatal cases due to accidental or intentional arsenic overdose; form of arsenic not stated
	N/A	No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	1.1 mg As^{3+}/kg (100 mg/kg as As_2O_3)	MLD for humans
	N/A	No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	1.3-2.2 mg As^{3+}/kg (120-200 mg as As_2O_3)	Lethal range in humans; arsenic compound and form not specified. We took a conservative approach and assumed the range was for As_2O_3.
	1.2 mg As^{3+}/kg (based on a default body weight of 10 kg) (2 mg /kg as $NaAsO_2$)	Dose that can cause death in children
	N/A	No LD_{50} for rat or mouse
RTECS	82 mg As^{3+}/kg (143 mg/kg as $NaAsO_2$)	LD_{Lo} in human adult (Gekkan Yakuji, 1999, Vol. 41, p. 1439). Reference is not available for review.
	1.2 mg As^{3+}/kg (2 mg/kg as $NaAsO_2$)	Human child – LD_{Lo}
	24 mg As^{3+}/kg (41 mg/kg as $NaAsO_2$)	Rat – LD_{50} (Vrednie chmichescie veshestva, 1993, p. 89). This is the same value as compiled by Smyth et al. (1969) (see below). This reference is not available to review.
	N/A	No LD_{50} for mouse

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	22- 87 mg As^{+3}/kg (2000-8000 mg as AS_2O_3)	Human lethal dose in four fatal case with known amount of arsenic ingested as a single bolus (Civantos et al., 1995; Hantson et al., 1996; Levin-Scherz et al., 1987; Quatrehomme et al., 1992). Civantos et al. reported a fatal case following ingestion of 21 g (300 mg/kg) of sodium arsenate, the pentavalent, but not the trivalent, form of arsenic. Levin-Scherz et al. reported a case of fatal overdose in which 2g of As_2O_3 (corresponding to 21.6 mg As^{3+}/kg, for a 70-kg person) was ingested. Hantson et al. study was on antimony, and not arsenic. Quatrehomme et al. reported a fatal case in which a 65-kg man fatally ingested 8 g of di-arsenic trioxide (corresponding to 87 mg As^{3+}/kg).
	145 – 190 mg As^{+3}/kg (as AS_2O_3 or $NaAsO_2$)	Rat – LD_{50} (Harrisson et al., 1958; Gaines, 1960; Dieke and Richter, 1946). Harrison et al. conducted a study on crude and pure arsenic trioxides and reported LD_{50} values of 23.6 As^{3+}/kg and 15.1 mg As^{3+}/kg for rats weighing 35-40 g, with the preferred value being for the pure trioxide. Dieke and Richter also reported LD_{50} value of 138 mg/kg for arsenic trioxide.
	47.6 mg As^{3+}/kg (as AS_2O_3)	Mouse – LD_{50} (Harrisson et al., 1958; Kaise et al., 1985). Harrison et al. conducted studies on crude (97.7%) and pure (99.999+%) and reported LD_{50} values of 42.9 As^{3+}/kg and 39.4 As^{3+}/kg, respectively, in mice weighing 20-25 g; the LD_{50} value for the purer arsenic in older mice (35-40 g) was 47.6 As^{3+}/kg. Lower values were also reported for other strains of mice weighing 17-20 g. Their results showed increasing resistance to arsenic trioxide with increasing age and weight. Therefore, LD_{50} of 47.6 mg As^{3+}/kg was preferred. Kaise et al. reported LD_{50} value of 34.5 mg AS_2O_3/kg (corresponding to 26.1 mg As_{3+}/kg) in 5-weeks-old mice. Since older adults are preferred for acute oral toxicity studies, Harrison et al. value of 47.6 mg As^{3+}/kg is reported.

Source	Oral Lethal Dose/Concentration*	Basis
Clinical Management of Poisoning and Drug Overdose	0.8-3 mg $As3^{+}$/kg (1-4 mg/kg as As_2O_3) N/A	"Potentially fatal human dose." We assumed range was for As_2O_3 No LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics–Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans
NIOSH	N/A 763 mg of As^{3+}/kg 145 mg of As^{3+}/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50}; valency of cation not specified (Davydova et al., 1987). Reference is in a foreign language and was not reviewed. Mouse – LD_{50}; valency of cation not specified (Davydova et al., 1987). Reference in a foreign language and was not retrieved.
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	N/A 24 mg As^{3+}/kg (41 mg $NaAsO_2$/kg) N/A	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} [Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996, p. 2947]. Smyth et al. (1969 - Am. Ind. Hyg. Assoc. J. 30:470-476) reported this value, but is likely for a commercial preparation of sodium arsenite. No LD_{50} for mouse
Patty's Industrial Hygiene and Toxicology	1 mg/kg (130 mg with form unspecified assuming 70-kg person) 10-15 mg As^{3+}/kg	Smallest reported fatal dose; however, recovery has occurred after much larger doses (Clayton and Clayton, 1994). The source as reported in Patty's is an older edition of the same reference. Mouse – LD_{50} (Fowler in: Goyer and Mehlman, 1977 as cited in Patty's). These references are not available for review.

Source	Oral Lethal Dose/Concentration*	Basis
Sax's (Lewis R.J.)	1.4-286 mg/kg (assumed to be sodium arsenite)	Human LD_{LO} (Yakkyoku 31, 1247, 1980; Annals of Emergency Medicine 16, 702, 87; J. Toxicol. Clin. Toxicol. 29, 45, 1991). This reference is not available for review.
Ward (1946)	1.1-11 mg As^{3+}/kg (1.5-15.0 mg/kg as arsenous acid – As_2O_3)	Accepted lethal dose to man; no source was provided for the value.
Cyanide (sodium cyanide) [143-33-9]		
Handbook of poisoning	2 mg CN^- /kg	LD_{50} in experimental animal(s); species not specified
Disposition of Toxic Drugs and Chemicals in Man	1.2 mg CN^-/kg (200 mg KCN, corresponding to 3 mg KCN/kg); 0.7 -1.4 mg CN^-/kg (50-100 mg as HCN); 0.86-1.4 mg CN^-/kg (150-250 mg as KCN) 1100-53100 mg/L (average, 12420 mg/L) 0.4-230 mg/L (average, 37 mg/L) N/A	MLD for humans. Ballantyne (1974) reported 50-100 mg (HCN) and 150-250 mg (KCN) as MLDs for humans, citing Dubois and Geiling (1959), Guatelli (1964), Dreisbach (1966), Camps and Cameron (1971), and Halstrom and Moller (1945). Blood cyanide concentration in 34 fatal cases after oral intake (Ballantyne, 1974). The author reported blood concentrations of 110-5310 mg/100 ml. Blood cyanide concentration in 32 fatal cases, after ingestion of cyanide (Rehling, 1967). Range of values confirmed, No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	1.1-1.3 mg CN^-/kg (1.4 mg/kg as HCN, 2.1 mg/kg as NaCN, and 2.9 mg/kg as KCN; based on a 70-kg person) 1 mg/dL N/A	MLD for humans (150 mg for sodium cyanide, 200 mg for potassium cyanide, and 100 mg for hydrogen cyanide, based on a 70-kg person); no references given in this secondary source. Approximate lethal blood level; form of cyanide not specified No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Medical Toxicology: Diagnosis and treatment of human poisoning	200-300 mg (1.2-1.6 mg CN^-/kg; 3-4 mg/kg, for cyanide salts (e.g. potassium cyanide)	Lethal oral adult dose
	0.5-2.0 mg CN^-/kg (1.2-5 mg/kg KCN)	Calculated lethal dose in children
	N/A	No LD_{50} for rat or mouse
RTECS	1.5 mg CN^-/kg (2.8 mg NaCN/kg)	Human – LD_{Lo} (National Technical Information Service, OTS0528336). This reference has not been reviewed.
	5.3 mg CN^-/kg (10 mg NaCN/kg)	Human child – LD_{Lo} (Forensic Science International, 1988, Vol. 38, p. 173)
	2.5 mg CN^-/kg (4.7 mg NaCN/kg)	Rat – LD_{50} (Vrednie chemichescie veshestva, 1988, p. 342). This reference has not been reviewed.
	N/A	No LD_{50} for mouse

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	0.56 mg CN^-/kg (as HCN); 0.48 mg absorbed CN^-/kg	Lowest fatal oral dose reported in humans (Gettler and Baine, 1938). The authors reported the LD_{LO} of cyanide to be 50-60 mg (calculated as HCN, corresponding to 0.7-0.9 mg CN^-/kg, for a 70-kg person) for an average human adult. This is not a primary source of the value, and the authors stated that the value was taken mainly from the history of the cases. Furthermore, the authors determined that most of the ingested cyanide is not absorbed into the body proper, with the unabsorbed dose present in the GI having no bearing on the death. They, therefore, contended that the minimal lethal dose should be reported in terms of the absorbed dose. Based on 4 case studies, these authors reported a minimum lethal absorbed dose of 0.5 mg HCN/kg and the average absorbed lethal dose as 1.4 mg HCN/kg.
	1.52 mg CN^- /kg	Adult fatal dose calculated from case report studies of intentional or accidental poisonings
	3-8 mg CN^- /kg (5.7-15 mg NaCN/kg)	Rat – LD_{50} (Ballantyne 1988; Smyth et al., 1969). Ballantyne (1988) reported value of 5.1 mg/kg and 5.7 mg/kg for starved and unstarved rats, respectively. Smyth et al. also reported 15 mg/kg for commercial grade NaCN.
	N/A	No LD_{50} for mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	N/A	No LD_{50} for rat
	4.2-4.4 (8 mg NaCN/kg) and 11 mg KCN /kg	Mouse – LD_{50}; no source was provided for the value.

Source	Oral Lethal Dose/Concentration*	Basis
NIOSH	0.7-1.4 mg CN^-/kg (50-100 mg CN^-)	Human lethal dose (Clayton and Clayton, 1982).
	2- 3.4 mg CN^-/kg (5-6.44 mg/kg as NaCN or KCN)	Rat – LD_{50} (Sterner, 1979). Sterner (1979) study was conducted on coyotes; hence not relevant for the present analysis. Instead, Marhold (1972) and Lorke (1983) values are reported here. Lorke (1983) reported a range of 5-9 mg/kg for KCN, depending on the number of animals (1-5) used in the study; use of 3-5 rats provided a value of 5 mg/kg. Marhold (1972) is not available for review.
	N/A	No LD_{50} for mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	2 mg CN^-/kg (5 mg/kg as KCN and 3.8 mg as NaCN)	Rat – LD_{50}
	3.6 mg CN^-/kg (9 mg/kg as KCN and 6.8 mg as NaCN)	Mouse – LD_{50}
Clinical Toxicology of Commercial Products	0.69-1.2 mg CN-/kg (50-90 mg HCN; 200 mg KCN)	The average lethal dose was believed to be 60-90 mg of HCN, corresponding to 200 mg of KCN (Gettler and St. George, 1934; Gettler and Baine, 1938), while some people who have swallowed 3 to 5 g of KCN have survived without specific therapy (Liebowitz and Schwartz, 1948). According to Gettler and St. George, the accepted lethal dose of cyanide is 50 mg, calculated as HCN.
	N/A	No LD_{50} for rat
	10 mg/kg	Mouse – LD_{50}
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	3.4 mg CN^-/kg (6.4 mg/kg sodium cyanide)	Rat – LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996, p. 2958). Sbornik Vysledku , p. 13, 1972 (as cited in Sax's).
	N/A	No LD_{50} for mouse

Source	Oral Lethal Dose/Concentration*	Basis
Sax's (Lewis R.J.)	0.5-1.1 mg CN^-/kg (0.57 mg/kg for HCN; 2.86 mg/kg for KCN)	Human LD_{Lo} (Pesticide Chemicals Official Compendium, pg. 596, 1966; Deichmann and Gerarde, 1969 – Toxicology of Drugs and Chemicals, p. 191, 1969). Deichmann and Gerarde (1969) reported sodium and potassium cyanide ranges of 200 to 250 mg (equivalent to 1.1-1.9 mg/kg for a 70-kg person) as the lethal oral adult dose, but gave no reference.
	2 mg CN^-/kg (5 mg/kg for KCN)	Rat – LD_{50} (Lorke, 1983 - Arch. Toxicol. 54, 275, 1983). Lorke (1983) reported a range of 5-9 mg/kg for KCN, depending on the number of animals (1-5) used in the study; use of 3-5 rats resulted in a value of 5 mg/kg, while 6-9 mg/kg was obtained using 1-2 animals.
	3.3-3.4 mg CN^-/kg (3.7 mg/kg for HCN; 8.5 mg/kg for KCN)	Mouse – LD_{50} (Annales Pharmaceutiques Francaises 19, 740, 1961; J. Pharmacol, Exp. Ther. 161, 163, 1968).
Patty's Industrial Hygiene	0.5-1.0 mg CN^-/kg (1-2 mg/kg as NaCN)	Fatal dose in man (Hartung, 1982). Hartung (1982) cited another source for the value.
Sheehy and Way (1968)	3.4 mg CN^-/kg (8.5 mg/kg as KCN)	Mouse – LD_{50}. This is a primary source for this value.
Fluoroacetate (sodium fluoroacetate) [62-74-8]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	0.7 to 1.4 mg/kg (for a 70 kg person (50-100 mg fluoroacetate)	Estimated human fatal dose
	0.22 mg fluoroacetate/kg (as fluoroacetic acid)	Rat - LD_{50}
	N/A	No LD_{50} for mouse
Disposition of Toxic Drugs and Chemicals in Man	1.5-7.7 mg fluoroacete/kg (140-700 mg for sodium fluoroacetate)	Mean lethal dose for an adult
	N/A	No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Medical Toxicology: Diagnosis and treatment of human poisoning	2-10 mg/kg (mean 5 mg/kg)	Estimates of mean lethal dose for humans (Gajdusek and Luther, 1950). The authors reported the estimated LD_{50} value for man as 5 mg/kg, but gave no reference. The form of fluoroacetate was not specified; therefore, value is excluded from analysis – this is unlikely to affect the results.
	N/A	Rat – LD_{50}. A value of 5 mg/kg was reported, citing Gajdusek and Luther (1950) as the source. Gajdusek and Luther (1950) also cited Chenoweth and Gilman (1946) for the LD_{50} value. However, Chenoweth and Gilman (1946) reported a value of 4 mg/kg for methyl fluoroacetate.
RTECS	0.6 mg fluoroacete/kg (50 mg for sodium fluoroacetate)	LD_{Lo} in humans (Deichmann and Gerarde – Toxicology of Drugs and Chemicals, 1969, p. 542) (as cited in Sax's). Deichmann and Gerarde (1969) reported 50 mg sodium fluoroacetate as the probable lethal oral dose for an adult, but gave no reference. For a 70-kg person, this dose is 0.7 mg/kg).
	0.8 mg fluoroacetate/kg (1 mg/kg sodium fluoroacetate)	Rat – LD_{50} (Ward, 1946 - American Journal of Public Health and the Nation's Health, 1946, Vol. 36, p. 1427) (as cited in Sax's). The value reported by Ward (1946) was 1.0 mg/kg for rat (black species) and 3-4 mg/kg for Norway rat. Therefore, the RTECS value of 0.1 mg/kg has been replaced with 1.0 mg/kg.
	0.08 mg fluoroacetate/kg (0.1 mg/kg sodium fluoroacetate)	Mouse – LD_{50} (Yakkyouku, 1977, Vol. 28, p. 182) (as cited in Sax's). This reference is not available for review.
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	3.9 mg fluoroacetate/kg (5 mg/kg sodium fluoroacetate)	Estimated lethal dose for humans (Proctor and Hughes, 1978). Proctor and Hughes cited Harrison et al. (1952a, b) as the source of the value; see below.
	N/A	No LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
NIOSH	0.55 mg fluoroacetate/kg (50 mg sodium fluoroacetate)	Lethal dose for humans (Deichmann and Gerarde, 1969). Deichmann and Gerarde (1969) reported 50 mg sodium fluoroacetate as the probable lethal oral dose for an adult, but gave no reference. For a 70-kg person, this dose is equivalent to 0.7 mg/kg).
	1.3 mg fluoroacetate/kg (1.7 mg/kg sodium fluoroacetate)	Rat –LD_{50} (Lehman, 1951). This reference is not available for review.
	0.08 mg fluoroacetate (0.1 mg/kg sodium fluoroacetate)	Mouse – LD_{50} (Yakkyoku, 1977). This reference is in a foreign language and was not reviewed.
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	4.6 mg fluoroacetate/kg (6 mg/kg sodium fluoroacetate)	Mean lethal dose in human adults (Gajdusek and Luther, 1950; Harrison et al,, 1952a and b). Harrison et al. stated that the mean lethal dose of 5 mg/kg value was estimated on the basis of animal studies. However, these authors reported a fatal case following ingestion of 6 mg/kg sodium fluoroacetate. Therefore, the 2-10 mg/kg sodium fluoroacetate as reported earlier is replaced with 6 mg/kg..
	N/A	No LD_{50} for rat or mouse
HSDB	0.39 mg fluoroacetate/kg (0.5 mg/kg sodium fluoroacetate)	Mouse - LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996, p. 2966); J. Am. Pharmaceutical Association 37, 307, 1948 (as cited in Sax's)
DuBois (1942)	2.5-5.0 mg/kg	Rat - LD_{50}. The author reported values of 2.5 mg/kg for white rats and 5.0 mg/kg for Norway rats. However, it appears the source of the values was Chenowith and Gilman (1946).
	0.5 mg/kg	Mouse - LD_{50}. The author reported a value of 0.5 mg/kg for meadow mice. However, it appears the source of the value was Chenowith and Gilman (1946).

Source	Oral Lethal Dose/Concentration*	Basis
Strychnine [57-24-9]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	(0.2 -0.4 mg/kg; for a 70-kg person) (15-30 mg) N/A	Fatal dose in humans. Although the secondary source did not provide a reference, Palatnick et al. (1996), cited in Sax's, also gave the same range as the fatal dose in humans. No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	60-100 mg (0.9-1.4 mg/kg; for a 70-kg person) 0.5-61 mg/L (average, 21 mg/L) N/A	Fatal to human adult. Strychnine blood concentration in 14 fatal cases that resulted from the ingestion of as much as 14 g of strychnine (Bogan et al., 1966; Sedgwick, 1973; Alha et al., 1974; Mohseni and Ahbab, 1975; Bailey, 1976; Schepens, 1984; Winek, 1986). Winek (1986) reported plasma strychnine level of 2.6 mg/L following a fatal case in which a 51-year old main ingested approximately half a can (2.5 oz) of a preparation that contains 0.35% strychnine sulfate) (reported as 263 mg of strychnine sulfate). No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	30 mg/70 kg person (0.4 mg/kg) 0.2 mg/dL (or less) N/A	MLD in humans Approximate lethal blood level; half-life of about 5 hours No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Medical Toxicology: Diagnosis and treatment of human poisoning	5-8 mg/kg	Estimated lethal dose in humans; adults develop symptoms with 30-80 mg and death occurs from 100-mg doses; one-half of the absorbed dose is distributed to tissues within 5 minutes; volume of distribution is large; elimination half-life was 10 hours in a severe overdose case, when serum concentration displayed first-order kinetics.
	0.5-6.1 mg/L	Fatal blood levels [Baselt and Carvey, (1977); McBay (1973); Winek et al., 1986). Baselt and Carvey, (1977) did not report on strychnine fatal blood level in their report. McBay (1973) reported blod level of 2 mg/L in his review. Winek et al. (1986) reported a postmortem blood strychnine level of 2.6 mg/L in a man who died shortly after ingesting an estimated 263 mg of strychnine sulfate (see above).
	N/A	No LD_{50} for rat or mouse
RTECS	0.4-0.8 mg/kg (30-60 mg; body weight of 70 kg assumed)	LD_{Lo} in humans (Pesticide Chemicals Official Compendium, 1966, p. 1073; The British Crop Protection Council, 1991, Vol. 9, p. 771; Journal of Toxicology, Clinical Toxicology, 1992, Vol. 30, p. 269). Pesticide Chemicals Official Compendium (1966) reported the human lethal dose as 30-60 mg, corresponding to a lethal dose of 0.4 – 0.8 mg/kg, for a 70-kg person); no source was given for the value.
	1-30 mg/kg	Rat – LD_{50} (Pesticide Chemicals Official Compendium, 1966, p. 1073); no reference was given in this secondary source.
	2.35 mg/kg (females); 6.5 mg/kg (males	Rat – LD_{50} (Ward and Crabtree, 1942 – J. Am. Pharm. Ass. 1942, Vol. 31, p. 113), 1942.) (as cited in Sax's). This is a primary source for the value for the alkaloid. The authors also reported 2.6 mg/kg (females) and 6.5 mg/kg (males) for strychnine as the sulfate.
	2 mg/kg	Mouse – LD_{50} (Indian Journal of Experimental Biology, 1981, Vol. 19, p. 1075) (as cited in Sax's). This reference is not available for review.

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Management of Poisoning and Drug Overdose	N/A	Mouse – LD_{50} (Mosher et al., 1964). The authors did not report any value in mice for strychnine. Therefore, the 0.5 mg/kg reported is replaced with N/A
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	100-120 mg (reported as 1.5-2 mg/kg) N/A	Mean lethal dose in man; 16 mg has killed an adult; 30 mg is usually a threat to life, while recovery has followed the ingestion of more than 2000 mg (Witthaus, 1911). Witthaus (1911) reviewed case reports and reported an MLD of 30 mg, and several fatal cases involving ingestion of 48-1300 mg, while recovery has followed ingestion of 970-2600 mg. No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
HSDB	5-10 mg	Fatal dose in humans (Ellenhorn and Barceloux, 1997). Note: It appears this dose is in mg/kg since the source quoted the value as 5-8 mg/kg; see "Medical Toxicology: Diagnosis and treatment of human poisoning" above, and this value would be more consistent with the other estimates.
	30-120 mg/kg	MLD or fatal dose in humans (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 2966; Zenz et al., 1994; Gossel and Bricker, 1994)
	0.9-1.2 mg/L	Lethal strychnine blood concentration (Gossel et al., 1994). This reference is not a primary source for the value.
	2.35 mg/kg	Rat – LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 2966). Ward and Crabtree, 1942 – J. Am. Pharm. Ass. 1942, Vol. 31, p. 113), 1942) (as cited in Sax's). This is a primary source for the value for the alkaloid. The authors also reported 2.6 mg/kg (females) and 6.5 mg/kg (males) for strychnine as the sulfate.
	2 mg/kg	Mouse – LD_{50} (Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996, p. 2966) (as cited in Sax's).
Heiser et al. (1992)	68.7 mg/kg (for a 70-kg person)	Fatal dose following ingestion of 4.8 g by a 51 year-old male. Serial strychnine blood levels of 3.8 and 3.6 mg/L were measured 0.5 and 8 hours, respectively, post ingestion.
DuBois (1942)	25 mg/kg	Rat – LD_{50} The author did not provide the source for the value.
Ward (1946)	1.0 mg/kg	Accepted lethal dose to man; no source was provided for the value.

Source	Oral Lethal Dose/Concentration*	Basis
Thallium [7440-28-0]		
Handbook of Poisoning: Prevention, Diagnosis & Treatment	14.3 mg Tl^+/kg; for a 70-kg person) (1000 mg of absorbed thallium) N/A	Approximate fatal dose in humans; assumed dose reported was for thallium. No LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	1000 mg (of a soluble thallium salt) (14.3 mg thallium/kg; for a 70-kg person) 2.9-243 mg Tl^+/kg (for a 70-kg person (0.0.2-17 g) N/A	Average lethal dose in an adult; thallium salt used was not specified; no adjustment to dose made based on molecular weight of salt used. This secondary source cited other references with relevant information. These references were retrieved and reviewed. For example, Smith and Doherty (1964) reported ingestion of 8 mg/kg (citing Munch, 1934) by human adults to result in death. Munch (1934), citing other investigators, reported toxic reactions in children following does of 8 mg/kg (likely to be thallium acetate); therefore, the value is not applicable to human adults, Grunfeld and Hinistroza (1964) reported a lethal dose for humans from 0.2-10 g of thallium (citing Conley, 1957). These authors also reported a fatal case in which >3000 mg of thallium sulfate (corresponding to >17.4 mg Tl^+/kg, based on body weight of 70 kg) was ingested. Hologgitas et al. (1980) reported a fatal case in which a patient who ingested approximately 17 g of thallium as the metal. Based on the referenced sources, the case studies identified lethal doses of 0.2-17 g. Although Conley (1957) is not available for review, and it is not clear whether the 0.2-10 g reported as the lethal dose for humans were in terms of thallium as a metal or some form of thallium, we assume it is the thallium metal; note that use of this value is conservative. No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	11.4 mg Tl^+/kg (800 mg thallium) 0.05 mg Tl^+/dL N/A	MLD in humans Approximate lethal blood level No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Medical Toxicology: Diagnosis and treatment of human poisoning	(14.3 mg Tl^+/kg; for a 70-kg person) (1000 mg (of a soluble thallium salt)	Average lethal oral dose in an adult.; thallium salt used was not specified; no adjustment to dose made based on molecular weight of salt used
	30 µg Tl^+/dL	Blood thallium level above value indicates severe ingestion. Thallium is reported as quickly absorbed from the gastrointestinal tract and primarily distributed intracellularly with a large volume of distribution (approximately 50 L); elimination half-life is approximately 1.9 days (Lund, 1956). The level reported is likely to be found in a second 1956 article by the author which was not available for review.
	N/A	No LD_{50} for rat or mouse
RTECS	4.4 mg Tl^+/kg	Human - LD_{Lo}; route of administration not specified; assumed to be oral (Arena 1970. Poisoning; Toxicology, Symptoms, Treatments, Vol. 2, p. 73). Arena (1970) reported 0.3 g as the MLD for a 150-lb person (i.e., approximately 4.4 mg/kg), but no reference was given in this secondary source.
	7 mg Tl^+/kg	Human – LD_{50}; route of administration not specified; assumed to be oral (Vrednie chemichesie veshestva, 1988, p. 242). This reference is not available for review.
	N/A	No LD_{50} for rat or mouse
ATSDR	55-110 mg Tl^+/kg (body weight assumed to be 70 kg.	Estimated lethal dose in one individual (Davis et al., 1981). This was a case report in which a 19-year old man deliberately ingested 5-10 g of thallium nitrate; victim died on the 9th day following ingestion.
	29-39 mg Tl^+/kg (as thallium acetate or oxide)	Rat –LD_{50} (Downs et al., 1960); Downs et al. conducted their studies on weanling, but not adult rats.
	N/A	No LD_{50} for mouse

Source	Oral Lethal Dose/Concentration*	Basis
Clinical Management of Poisoning and Drug Overdose	5.8 mg Tl^+/kg (8 mg/kg as thallium sulfate) N/A	Lethal oral dose for humans (Moeschlin, 1980). According to Moeschlin (1980), thallium lethal dose varies considerably from case to case, with the average lethal dose for thallium sulfate being approximately 1 g in the adult. The author reported fatalities with 8 mg/kg, with the usual lethal dose being higher (10-15 mg/kg). No LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics – Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A N/A N/A	No LD_{Lo}, MLD, or lethal dose for humans Rat - LD_{50} 16 mg/kg (for thallium sulfate) reported as cited in RTECS (1997). The 2005 updated RTECS did not list any value for the rat, therefore, dose was not used in the analysis) Mouse – LD_{50} 24 mg/kg for thallium sulfate reported as cited in RTECS (1997). The 2005 updated RTECS did not list any value for the mouse, therefore, dose was not used in the analysis)
Clinical Toxicology of Commercial Products	14.3 mg Tl^+/kg (for a 70-kg person) (1000 mg (thallium sulfate) 4 mg Tl^+/kg N/A	Mean lethal dose in human adult; although the dose was listed as that for thallium sulfate, it is likely to be for thallium; therefore, dose was converted to mg thallium/kg without any adjustment. Dose that caused toxic reactions in children (Munch, 1928) No LD_{50} for rat or mouse
HSDB	14.3 mg Tl^+kg (for a 70-kg person) (1000 mg (of absorbed thallium) N/A	Reported adult fatal dose; assumed dose reported was for thallium. No LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Patty's Industrial Hygiene and Toxicology	8 – 12 mg Tl^+/kg	Reported human lethal dose for thallium (Moeschlin, 1980; Lynch et al., 1948; *Gekkan Yakuji*, 22, 91,1980 cited in RTECS). Gekkan Yakuji reported 12 mg/kg as the oral human LD_{Lo} for the acetate, but the reference is not available for review. Moeschlin (1980) (see above) reported fatalities with 8 mg/kg, with the usual lethal dose being higher (10-15 mg/kg).
	35 mg Tl^+/kg (3000 mg/kg thallium sulfate)	Several human lethal doses for thallium sulfate have been reported: 2.2 mg/kg (*Yakkyoku* 28, 329, 1977 cited from RTECS), 3 mg/kg (Venugopal and Luckey, 1978), and 45 mg/kg based on lethal dose of 3.2 g thallium sulfate (Grunfeld and Hinostroza, 1964). Venugopal and Luckey (1978) reported the computed lethal dose in humans as 8-10 mg Tl^+/kg on the basis of the death of a 10-year-old boy who was given a therapeutic dose of 166 mg thallium acetate (citing Browning, 1969). Grunfeld and Hinistroza (1964) (see above) reported a lethal dose for humans from 0.2-10 g (citing Conley, 1957) and a fatal case involving ingestion of 3000 g of thallium sulfate (corresponding to 35 mg Tl^+/kg, based on body weight of 70 kg). *Yakkyoku* (1977) is not available for review; however, RTECS did not cite this reference (see above). Therefore, value is excluded until verified.
	54 mg Tl^+/kg (70 mg/kg thallium nitrate, based on LD_{LO} of 5 g and assuming a 70 kg person)	For thallium nitrate, estimated human oral lethal doses were reported as 5-10 g (Davis et al., 1981). This was a case report in which a 19-year old man deliberately ingested 5-10 g of thallium nitrate; victim died on the 9th day following ingestion
	6.5- 32 mg Tl^+/kg (16 mg/kg for the sulfate, 41.3 mg/kg for the acetate, and 23 mg/kg for the nitrate).	Rat – LD_{50} Values range from 16 mg/kg for sulfate (*Gekkan Yakuji*, 22, 91,1980, cited in RTECS), 41.3 mg/kg for the acetate (Venugopal and Luckey, 1978), and 23 mg/kg for the nitrate (*Gig Sani* 29, 26, 1964 cited from RTECS). Venugopal and Luckey (1978) reported the computed lethal dose in humans as 8-10 mg Tl^+/kg on the basis of the death of a 10-year-old boy who was given a therapeutic dose of 166 mg thallium acetate (citing Browning, 1969).
	10-27 mg Tl^+/kg (25 mg/kg for the sulfate, 35 mg/kg for the acetate, and 15 mg/kg for the nitrate).	Mouse – LD_{50} – Values range from 25 mg/kg for sulfate (*Gig Sani* 29, 26, 1964 cited from RTECS), 35 mg/kg for acetate (J Fac Agric 5, 15, 1969 cited from RTECS), and 15 mg/kg for nitrate (*Yakkyoku* 28, 329, 1977 cited from RTECS), and 21 mg/kg fro carbonate (Sanotskii, 1961).

Source	Oral Lethal Dose/Concentration*	Basis
Dieke and Richter, 1946	12.8 mg Tl^{+}/kg (as thallium sulfate)	Rat – LD_{50}. This is a primary source for this value.
Ward (1946)	8.1 mg Tl^{+}/kg (20.0 mg/kg as thallium sulfate)	Accepted lethal dose to man; no source was provided for the value.
Toluene [108-88-3]		
Handbook of poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Disposition of Toxic Drugs and Chemicals in Man	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A 1 mg/L N/A	No LD_{Lo}, MLD, or lethal dose for humans Characterized as highly toxic or lethal blood (plasma) levels; authors stated value can vary widely depending upon many factors No LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
RTECS	50 mg/kg	A Human - LD_{Lo} of 50 mg/kg was reported (Gekkan Yakuji, 1980, Vol. 22, p. 883). Note however, that in another case report 625 mg/kg resulted in serious illness but was not fatal (Cohen and Maier, 1974). This reference is not available for review.
	5500-5580 mg/kg	Rat – LD_{50} (Benignus, 1981; Neurotoxicology, 1981, Vol. 2, p. 567). Benignus (1981), in his review of the health effects of toluene, reported LD_{50} values of 636 mg/kg and 5580 mg/kg from Kimura et al. (1971) and Withey and Hall (1975), respectively. However, Kimura et al. reported LD_{50} values of 6.4 ml/kg [corresponding to 5527 mg/kg – not 636 mg/kg] for non-fasted, young adult rats that were observed for 7 days following exposure. The value is similar to the Withey and Hall value of 5580 mg/kg. Kimura et al. also reported values in 14-day old and "older" adults of 3 ml/kg (2.6 g/kg) and 7.4 ml/kg (6.4 g/kg), respectively.
	N/A	No LD_{50} for mouse

Source	Oral Lethal Dose/Concentration*	Basis
ATSDR	N/A	Ameno et al. (1989) only reported toluene concentrations (total was approximately 1940 μg/kg) in various fluids and tissues of the 51-year old victim who weighed 83.5 kg.
	29-119 μg/kg	Blood toluene levels in three fatal cases due to acute poisoning (Kashima et al., 1981; cited by Ameno et al., 1989)
	5500–7000 mg/kg	Rat – LD_{50} (Kimura et al., 1971; Smyth et al., 1969; Withey and Hall, 1975; Wolf et al., 1956). Kimura et al. reported LD_{50} values of 6.4 ml/kg (corresponding to 5527 mg/kg). Smyth et al. reported a value of 7.53 ml/kg (corresponding to 6500 mg/kg) and 7.80 ml/kg (or 6736 mg/kg) in another study (Smyth et al., 1969; Toxciol. Appl. Pharmacol. 14:340-347). Withey and Hall reported a value of 5580 mg/kg in their study and compared it to 6760 mg/kg obtained from the study by Wolf et al. Wolf et al. reported the value to be 7000 mg/kg.
	N/A	No LD_{50} for mouse
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
The Pharmacological Basis of Therapeutics–Goodman and Gilman's	N/A	No LD_{Lo}, MLD or lethal oral dose reported for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
HSDB	N/A 5500 - 6400 mg/kg N/A	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (DHHS/NTP; Toxicology and Carcinogenesis Studies of Chlorobenzene in F344/N Rats and B6C3F1 Mice (Gavage Studies) p.16 (1990) Technical Rpt Series No. 371 NIH Pub No. 90-2826). This reference should have been "NTP (National Toxicology Program). 1990. *Toxicology and Carcinogenesis Studies of Toluene (CAS No. 108-88-3) in F344/N Rats and B6C3F$_1$ Mice (Inhalation Studies)*. Technical Report Series No. 371. U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, Research Triangle Park, NC". The NTP (1990) study listed a range of LD_{50} values of 2.6-7.5 g/kg for juvenile to adult rats, citing Cameron et al. (1938), Kimura et al. (1971), Withey and Hall (1975), and Ungvay et al. (1979). Since Kimura et al. (1971) reported a value of 2.6 g/kg for 14-day old (juvenile) rats and 6.4 g/kg ("older" adults) (see above) and Withey and Hall (1975) reported a value 5580 mg/kg, a range of 5.5-6.4 is recommended. [Cameron et al. (1938) is not available for review. No LD_{50} for rat mouse
Trichloroethylene [79-01-6]		
Handbook of poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse

Source	Oral Lethal Dose/Concentration*	Basis
Disposition of Toxic Drugs and Chemicals in Man	N/A 3-110 mg/L (average, 27 mg/L) N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse Blood trichloroethylene concentration in 20 fatal cases after ingestion or inhalation; no documentation of dose available (James, 1963; Le Breton et al., 1963; Bonnichsen and Maehly, 1966; Cravey and Baselt, 1968; McAuley, 1970; Alha, 1964; Tadjer, 1977; Franc, 1983). The victim reported on by James (1963) died following inhalation exposure, but the author did not report any blood concentration. Le Bretton et al. study is in a foreign language and was not reviewed. Bonnichse and Maehly (1966) reported blood levels of 0.5-33 ppm (mg/L) in fatal cases, with survivors having levels of 0.3- 7.0 mg/L. No LD_{50} for rat or mouse
Handbook of Emergency Toxicology	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Medical Toxicology: Diagnosis and treatment of human poisoning	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
RTECS	7000 mg/kg 4920 mg/kg 2400 mg/kg	Human – LD_{Lo} (Sorgo, 1976 - Archives of Toxicology, Vol. 35, p. 295) (as cited in Sax's). Rat – LD_{50} (Vrednie chemichescie veshestva, 1990, p. 442) Mouse – LD_{50} (National Technical Information Service, AD-A080-636 (as cited in Sax's; values was 2402 mg/kg); Vrednie chemichescie veshestva, 1990, p. 442).
ATSDR	N/A N/A 2402-2443 mg/kg	No LD_{Lo}, MLD, or lethal dose for humans Rat – LD_{50} (Smyth et al., 1969). A value of 7208 mg/kg is not confirmed from any of the two studies conducted by this group; Toxicol. Appl. Pharmacol. 14 :340-347 and Am. Ind. Hyg. Assoc. J. 30_470-476. Mouse – LD_{50} (Tucker et al., 1982). This is a primary source for the values.

Source	Oral Lethal Dose/Concentration*	Basis
Clinical Management of Poisoning and Drug Overdose	N/A	No LD_{Lo}, MLD, or lethal dose for humans
The Pharmacological Basis of Therapeutics– Goodman and Gilman's	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
NIOSH	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
ATLA – Alternatives to Laboratory Animals	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
Clinical Toxicology of Commercial Products	N/A	No LD_{Lo}, MLD, or lethal dose for humans; no LD_{50} for rat or mouse
HSDB	N/A	No LD_{Lo}, MLD, or lethal dose for humans
	4920 mg/kg	Rat – LD_{50} (Hayes, W.J., Jr., E.R. Laws, Jr., (eds.). Handbook of Pesticide Toxicology. Volume 2. Classes of Pesticides. New York, NY: Academic Press, Inc., 1991., p. 690). This reference is not available for review.
	2402 mg/kg (male); 2443 mg/kg (female)	Mouse – LD_{50} (Hayes, W.J., Jr., E.R. Laws, Jr., (eds.). Handbook of Pesticide Toxicology. Volume 2. Classes of Pesticides. New York, NY: Academic Press, Inc., 1991., p. 690). This reference is not available for review.
Berman et al. (1995)	>5000 mg/kg	Rat – LD_{50}. This study did not estimate the actual value since trichloroethylene caused no mortality at the limit dose of 5000 mg/kg.

*All values based on a 70-kg individual
LD_{Lo} – lowest oral lethal dose
MLD – minimal lethal dose

Table 2. Summary of Human Lethal Low Doses (LD_{Lo})

Chemical	Human Lethal Doses (LDLo)* (mg/kg)													Average[d] (mg/kg)	Lowest reliable value[e] (mg/kg)
	Sources[#]														
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Acrylonitrile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aldicarb	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A
Ammonia (NH_4^+)**	49.4[b]	N/A	16.5[c]	N/A	22[a]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.6[b]	31.5	16.5
Copper (Cu^{2+})**	57[b]	57[b]	57[c]	N/A	20[a]	2.4[b, #]	N/A	N/A	341[b]	N/A	N/A	57[b]	46.3[b]	91	20
Dimethrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ethylene glycol	1430[b]	1570[b]	1570[c]	1100[c]	398[a]	1330[c]	1570[b]	N/A	N/A	N/A	1570[b]	N/A	3180	1502	398
Fenamiphos	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Geosmin (trans, trans-1,10-dimethyl-9-decalol	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mercury (Hg^{2+})**	10.5[b]	10.3[c]	5.3[c]	N/A	10.3[a]	10.3[b]	10.3[b]	N/A	N/A	N/A	10.3[b]	N/A	21	12.2	5.3
Methamidophos	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Methyl parathion	N/A	N/A	N/A	N/A	N/A	4[c]	N/A	N/A	N/A	N/A	N/A	N/A	5[c]	4.5	4
MIB (2-Methylisoborneol)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Microcystin-LR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nicotine	0.6[b]	0.6[c]	0.7[a]	0.6[b]	0.9[a]	N/A	0.9[b]	0.9[b]	0.7[b]	N/A	0.4[b]	0.9	0.9	0.7	0.4
Oxamyl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Paraquat **	2.9[b]	10[b]	0.8[c]	31[b]	0.7[a]	N/A	22[b]	N/A	N/A	N/A	22 [b]	25[c]	31	15	0.7
Pentachlorophenol	14[b]	28[b]	N/A	28	401[a]	14[a]	N/A	N/A	N/A	N/A	N/A	N/A	401[c]	148	14
Permethrin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phenol	28[a]	N/A	151[c]	143[b]	140[a]	14[a]	43[b]	N/A	14[b]	N/A	43[b]	50[b]	140[c]	72	14
Arsenic (As^{3+}) **	1.3[b]	2.2[b]	1.1[c]	1.3[a]	82[a]	22[b]	0.8[b]	N/A	N/A	N/A	N/A	N/A	1	15	0.8
Cyanide (CN^-)**	N/A	0.7[c]	1.1[c]	1.2[b]	1.5[a]	0.6[a]	N/A	N/A	0.7[b]	N/A	0.7	N/A	0.5[a,b]	0.9	0.5
Fluoroacetate **	0.7[b]	1.5[b]	N/A	2	0.6[a]	N/A	3.9[b]	N/A	0.6	N/A	4.6[b]	N/A	N/A	10.6	0.6

Chemical	Human Lethal Doses (LDLo)* (mg/kg)													Average[d] (mg/kg)	Lowest reliable value[e] (mg/kg)
	Sources[#]														
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Strychnine	0.2[b]	0.9[b]	0.4[c]	5[b]	0.4[a]	N/A	N/A	N/A	N/A	N/A	1.5[b]	5[b]	1.0	1.5	0.2
Thallium (Tl^+)**	14.3[b]	2.9[b]	11.4[c]	14.3[b]	4.4[a]	55[b]	5.8[b]	N/A	N/A	N/A	14.3[b]	14.3	8.0	7.5	2.9
Toluene	N/A	N/A	N/A	N/A	50[a]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50	50
Trichloroethylene	N/A	N/A	N/A	N/A	7000[a]	N/A	N/A	N/A	N/A	N/A	N/A	N/A		7000	7000

LD_{Lo}: Lowest oral published lethal dose for humans
*All values based on a 70-kg human adult
** Note that doses have been converted, as needed, to the dose of the chemical of interest (e.g., a lethal dose reported for sodium cyanide was converted to a cyanide dose based on the relative molecular weights of these two compounds)
[a]Human LD_{Lo} values
[b]Human oral lethal (fatal) dose
[c]MLDs; minimal lethal doses
[d]Averages calculated were based on the form of the chemical of concern
[e]Excludes values considered by the authors to be inaccurate
[#]Authors indicated this value is likely to be inaccurate
N/A: "not available"

[#]Sources:
1 – Handbook of Poisoning - Dreisbach and Robertson, 1987
2 – Disposition of Toxic Drugs and Chemicals in Man - Baselt and Cravey, 1989
3 – Handbook of Emergency Toxicology - Kaye, 1988
4 – Medical Toxicology: Diagnosis and treatment of human poisoning - Ellenhorn and Barceloux, 1988
5 – RTECS, 2004
6 – ATSDR, 2004
7 – Clinical Management of Poisoning and Drug Overdose - Haddad and Winchester, 1990
8 – The Pharmacological Basis of Therapeutics– Goodman and Gilman's - Hardman et al., 2001
9 – NIOSH, 2004
10 – ATLA (Alternatives to Laboratory Animals) 1998
11 -Clinical Toxicology of Commercial Products - Gosselin et al. 1984
12 -HSDB, 2005
13- Lowest of other secondary or primary references.

Table 3. Derivation of an Estimated Lethal Low Dose for Humans Based on Experimental Animal Data.

Chemical	**Reported Human LD_{Lo}[a]** (mg/kg)	**Experimental Animal LD_{50}[b]** (mg/kg)		**Estimated LD_{Lo} Based on Animal Data** (= LD_{50}/UF of 30)[d] (mg/kg)*		**Overall Estimated Human LD_{Lo}** (mg/kg)*
		Rat	Mouse	Rat	Mouse	
Acrylonitrile	N/A	78	27	3	0.9	0.9
Aldicarb	N/A	0.46	0.3	0.02	0.01	0.01
Ammonia (NH_4^+)**,[c]	16.5	180	N/A	6	N/A	6
Copper (Cu^{2+})**	20	119	34.6	4	1	1
Dimethrin	N/A	40000	10000	1000	300	300
Ethylene glycol	398	4000	5500	100	200	100
Fenamiphos	N/A	2.7	8.3	0.1	0.3	0.1
Geosmin (trans, trans-1,10-dimethyl-9-decalol	N/A	N/A	N/A	N/A	N/A	N/A
Mercury (Hg^{2+})	5.3	0.7	4.4	0.02	0.1	0.02
Methamidophos	N/A	7.5	20	0.3	0.7	0.3
Methyl parathion	4	6	12.4	0.2	0.4	0.2
MIB (2-Methylisoborneol)	N/A	N/A	N/A	N/A	N/A	N/A
Microcystin-LR	N/A	N/A	5	N/A	0.2	0.2
Nicotine	0.4	32	3.3	1	0.1	0.1
Oxamyl	N/A	2.5	2.3	0.08	0.08	0.08
Paraquat**	0.7	41	71	1	2	0.7
Pentachlorophenol	14	78	117	3	4	3
Permethrin	N/A	85	250	3	10	3
Phenol	14	317	270	10	9	9
Arsenic (As^{3+})**	0.8	24	10	0.8	0.3	0.3
Cyanide (CN^-)**	0.5	2	3.3	0.07	0.1	0.07
Fluoroacetate**	0.6	0.8	0.08	0.03	0.003	0.003
Strychnine	0.2	1	2	0.03	0.07	0.03
Thallium (Tl^+)**	2.9	6.5	N/A	0.2	N/A	0.2
Toluene	50	5500	N/A	180	N/A	50
Trichloroethylene	7000	4920	2400	160	80	80

* Corrected to 1 significant figure.
** Note that doses have been converted, as needed, to the dose of the chemical of interest (e.g., a lethal dose reported for sodium cyanide was converted to a cyanide dose based on the relative molecular weights of these two compounds)
a) Lowest reported lethal doses in humans
b) Lowest LD_{50} value reported in RTECS, ATSDR, and/or NIOSH

c) Ammonia in solution exists in equilibrium with ammonium hydroxide; value reported is for ammonium hydroxide.
d) Estimate is rounded to 1 digit of precision.
N/A: “not available”

Table 4. Recommended Lethal Low Doses (LD_{Lo}) for Humans

Chemical	Mean Human Minimal Lethal Dose as Reported by Ekwall et al. (1998)* (mg/kg)	Reported Human LD_{Lo} (mg/kg)	Estimated Human LD_{Lo} (mg/kg)	**Recommended Human LD_{Lo} (mg/kg)**
Acrylonitrile	N/A	N/A	0.9	**0.9**
Aldicarb	N/A	N/A	0.01	**0.01**
Ammonia (NH_4^+)**	N/A	16.5	6	**6**
Copper (Cu^{2+})**	53	20	1	**1**
Dimethrin	N/A	N/A	300	**300**
Ethylene glycol	1571	398	100	**100**
Fenamiphos	N/A	N/A	0.1	**0.1**
Geosmin (trans, trans-1,10-dimethyl-9-decalol	N/A	N/A	N/A	**N/A**
Mercury (Hg^{2+})**	5.3	5.3	0.02	**0.02**
Methamidophos	N/A	N/A	0.3	**0.3**
Methyl parathion	N/A	4	0.2	**0.2**
MIB (2-Methylisoborneol)	N/A	N/A	N/A	**N/A**
Microcystin-LR	N/A	N/A	0.2	**0.2**
Nicotine	0.5	0.4	0.1	**0.1**
Oxamyl	N/A	N/A	0.08	**0.08**
Paraquat**	1.9[a]	0.7	1	**0.7**
Pentachlorophenol	21	14	3	**3**
Permethrin	N/A	N/A	3	**3**
Phenol	94	14	9	**9**
Arsenic (As^{3+})**	1.9[b]	0.8	0.3	**0.3**
Cyanide (CN^-)**	1.1[c]	0.5	0.07	**0.07**
Fluoroacetate**	N/A	0.6	0.003	**0.003**
Strychnine	N/A	0.2	0.03	**0.03**
Thallium (Tl^+)**	3.9[d]	4.4	0.2	**0.2**
Toluene	N/A	50	180	**50**
Trichloroethylene	N/A	7000	80	**80**

*Values based on a 70-kg individual

** Note that doses have been converted, as needed, to the dose of the chemical of interest (see above)

a) Value reported by authors assumed to be that of paraquat dichloride

b) Value reported for arsenic trioxide by the authors

c) Value reported for KCN by the authors

d) Value reported for thallium sulfate by the authors

Table 5. Elimination and Absorption Rate Constants

Compound	ke (/hr)	ka (/hr)
Acrylonitrile	0.0053	0.85
Aldicarb	0.36	0.22
Ammonia (NH_4^+)*	4.6	-
Copper (Cu^{2+})*	0.012	-
Dimethrin	-	-
Ethylene glycol	0.12	3.5
Fenamiphos	0.040	17
Geosmin	-	-
Mercury (Hg^{2+})*	0.0088	-
Methamidophos	-	-
Methyl parathion	0.13	0.27
MIB	-	-
Microcystin-LR	-	-
Nicotine	1.4	-
Oxamyl	0.12	0.086
Paraquat*	0.063	6.2
Pentachlorophenol	0.023	0.96
Permethrin	0.080	-
Phenol	0.069	7.6
Arsenic (As^{3+})*	0.027	-
Cyanide (CN^-)*	0.69	56
Fluoroacetate*	0.064	-
Strychnine	0.069	0.25
Thallium (Tl^+)*	0.00096	0.086
Toluene	0.35	0.56
Trichloroethylene	0.035	95

* Elimination and absorption rate constants were often identified from kinetic studies using the metal salt or parent compound. However, since the form of the chemical measured in the blood or plasma is the ion, which is the chemical form of interest, these values are assumed appropriate.

Table 6. Multiple Dose Calculation

Compound	Recommended Human LD_{Lo} Single Dose (mg/kg)	half-life (hr)	time to peak (hr)	Multipler for 15L intake	Recommended Human LD_{Lo} Multiple Dose (mg/kg)*
Acrylonitrile	0.9	130	6.0	1.0	0.9
Aldicarb	0.01	1.9	3.5	3.7	0.04
Ammonia (NH_4^+)**	6	0.15	*NR****	12	70
Copper (Cu^{2+})**	1	60	*NR*	1.1	1
Dimethrin	300	*NR*	*NR*	1.0	300
Ethylene glycol	100	6	1.0	1.7	175
Fenamiphos	0.1	210	0.50	1.2	0.1
Geosmin	N/A	-	-	-	-
Mercury (Hg^{2+})	0.02	79	*NR*	1.0	0.02
Methamidophos	0.3	*NR*	*NR*	1.0	0.3
Methyl parathion	0.2	5.4	6.0	1.8	0.4
MIB	N/A	-	-	-	-
Microsystin-LR	0.2	-	-	-	-
Nicotine	0.1	0.5	*NR*	9.0	0.9
Oxamyl	0.08	6	*NR*	1.7	0.1
Paraquat**	0.7	11	0.75	1.4	1
Pentachlorophenol	3	30	4.0	1.1	3.4
Permethrin	3	8.7	*NR*	1.5	4
Phenol	9	10	0.62	1.4	13
Arsenic (As^{3+})**	0.3	26	*NR*	1.2	0.4
Cyanide (CN^-)**	0.07	1	0.17	6.0	0.4
Fluoroacetate**	0.003	11	*NR*	1.4	0.004
Strychnine	0.03	10	7.1	1.4	0.04
Thallium (Tl^+)**	0.2	720	2.0	1.0	0.2
Toluene	50	2	2.3	3.6	179
Trichloroethylene	80	20	0.083	1.2	96

*This column reflects the calculated **total** dose in 15 L of drinking water consumed at a rate of 1.25 L/hour over 12 hours. It is not the hourly allowable dose.

**Half-life estimates were often identified from kinetic studies using the metal salt or parent compound. However, since the form of the chemical measured in the blood or plasma is the ion, which is the chemical form of interest, these estimates are assumed appropriate.

***NR – Not reported.

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